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NATIONAL DAM SAFETY PROGRAM. DECOZEN'S DAM (NJ00353) PASSAIC RI—ETC(U)
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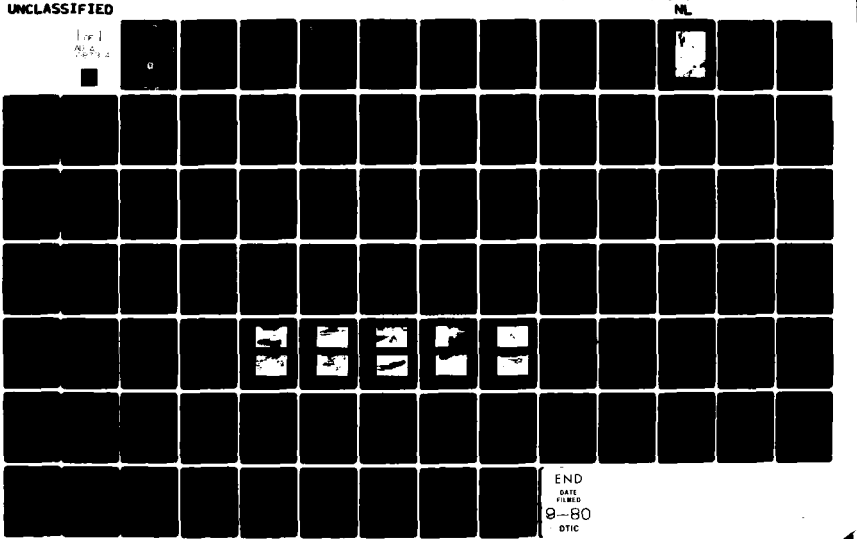

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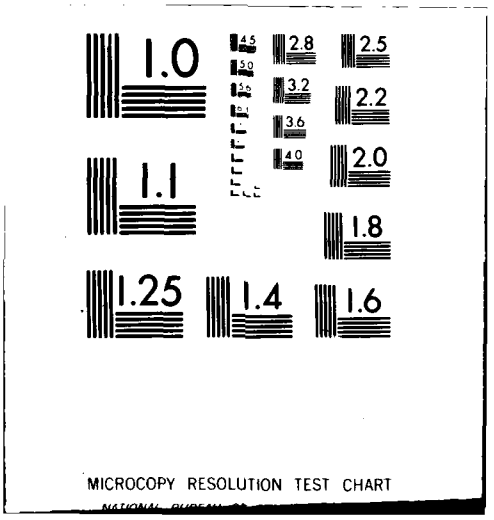
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LEVEL II

PASSAIC RIVER BASIN
TROY BROOK, MORRIS COUNTY
NEW JERSEY

# DE COZEN'S DAM
# NJ 00353





## PHASE 1 INSPECTION REPORT
## NATIONAL DAM SAFETY PROGRAM





DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania



APRIL 1980

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

# REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

| | |
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| 1. REPORT NUMBER: NJ00353 | 2. GOVT ACCESSION NO.: AD-A087374 |
| 3. RECIPIENT'S CATALOG NUMBER: | |
| 4. TITLE (and Subtitle): Phase I Inspection Report<br>National Dam Safety Program<br>DeCozen's Dam NJ00353<br>Morris County, New Jersey | 5. TYPE OF REPORT & PERIOD COVERED: FINAL |
| | 6. PERFORMING ORG. REPORT NUMBER: |
| 7. AUTHOR(s): RICHARD J. McDERMOTT | 8. CONTRACT OR GRANT NUMBER(s): DACW61-79-C-0011 |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS: Storch Engineering<br>220 Ridgedale Ave.<br>Florham Park, N.J. 07932 | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: |
| 11. CONTROLLING OFFICE NAME AND ADDRESS: NJ Department of Environmental Protection<br>Division of Water Resources<br>P.O. Box CN029<br>Trenton, NJ 08625 | 12. REPORT DATE: April, 1980<br>13. NUMBER OF PAGES: 82 |
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16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams
Embankments
Structural Analysis
Safety
Visual Inspection
National Dam Safety Program
De Cozen's Dam

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-N

24 JUL 1978

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for De Cozen's Dam in Morris County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, De Cozen's Dam, initially listed as a "high" hazard potential structure, but reduced to a "significant" hazard potential structure as a result of this inspection, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to nine percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood). To ensure adequacy of the structure, the following actions, as a minimum are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures and studies within one year from the date of approval of this report. Within three months of the consultant's findings, remedial measures to ensure spillway adequacy should be initiated.

b. The two areas of seepage observed at the toe of the dam should be monitored monthly in order to detect any changes in their condition.

c. With the lake drawn down, the concrete spillway and outlet structure should be thoroughly inspected by a professional consultant engaged by the owner within one year from the date of approval of this report. Based on the inspection, any necessary remedial measures should be determined and implemented. Also, the outlet structure should be repaired to prevent leakage during times of high lake stage.

d. Within one year from the date of approval of this report, the following remedial measures should be completed:

NAPEN-N
Honorable Brendan T. Byrne

(1) All trees on the embankment should be removed.

(2) The animal hole and erosion gully on the downstream side of the dam should be filled and sodded.

(3) The spillway discharge channel should be renovated to increase its capacity and prevent overflow.

e. Within six months from the date of approval of this report, the owner should develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

f. Within one year from the date of approval of this report, the owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congresswoman Fenwick of the Fifth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

## DE COZEN'S DAM (NJ00353)

## CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 14 November 1979 and 21 March 1980 by Storch Engineers under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

De Cozen's Dam, initially listed as a "high" hazard potential structure, but reduced to a "significant" hazard potential structure as a result of this inspection, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to nine percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood). To ensure adequacy of the structure, the following actions, as a minimum are recommended:

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d. Within one year from the date of approval of this report, the following remedial measures should be completed:

(1) All trees on the embankment should be removed.

(2) The animal hole and erosion gully on the downstream side of the dam should be filled and sodded.

(3) The spillway discharge channel should be renovated to increase its capacity and prevent overflow.

e. Within six months from the date of approval of this report, the owner should develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

f. Within one year from the date of approval of this report, the owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 7 July 1970

(10) Richard J. McDermott

(15) DACW61-79-C-0011

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(6)

# PHASE I REPORT
## NATIONAL DAM SAFETY PROGRAM

| | |
|---|---|
| Name of Dam: | DeCozen's Dam (NJ00353) |
| State Located: | New Jersey |
| County Located: | Morris |
| Drainage Basin: | Passaic River |
| Stream: | Troy Brook |
| Date of Inspection: | November 14, 1979 |

Passaic River Basin
Troy Brook, Morris County
New Jersey.
Phase I Inspection Report

(9) Final rept.

March 21, 1980

## Assessment of General Condition of Dam

Based on visual inspection, past operational performance and Phase I engineering analyses, DeCozen's Dam is assessed as being in fair overall condition.

Based on investigations of the downstream flood plain made in connection with this report, it is recommended that the hazard potential classification be downgraded from "High" to "Significant" hazard.

Hydraulic and hydrologic analysis indicate that the spillway is inadequate. The discharge capacity of the spillway is not sufficient to pass the designated spillway design flood (SDF) without an overtopping of the dam. (The SDF for DeCozen's Dam is equal to one-half the probable maximum flood.) The spillway is capable of passing approximately 4 percent of the probable maximum flood, or 8 percent of the SDF. Therefore, the owner should, in the future, engage a professional engineer experienced in the design and construction of dams to perform more accurate hydraulic and hydrologic analyses. Based on the findings of the analyses, the need for and type of remedial measures should be determined and then implemented.

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Two areas of seepage were observed at the toe of dam. Arrangements should be made in the near future to monitor the seepage on a monthly basis in order to detect any changes in its condition. The monitoring should be performed by a professional engineer experienced in the design and construction of dams.

In addition, it is recommended that the following remedial measures be undertaken by the owner in the future:

1) With the lake drawn down, the concrete spillway and outlet structure should be thoroughly inspected by a professional engineer experienced in the design and construction of dams. Based on the inspection, any necessary remedial measures should be determined and then implemented. Also, the outlet structure should be repaired to prevent leakage during times of high lake stage.

2) All trees on the embankment should be removed.

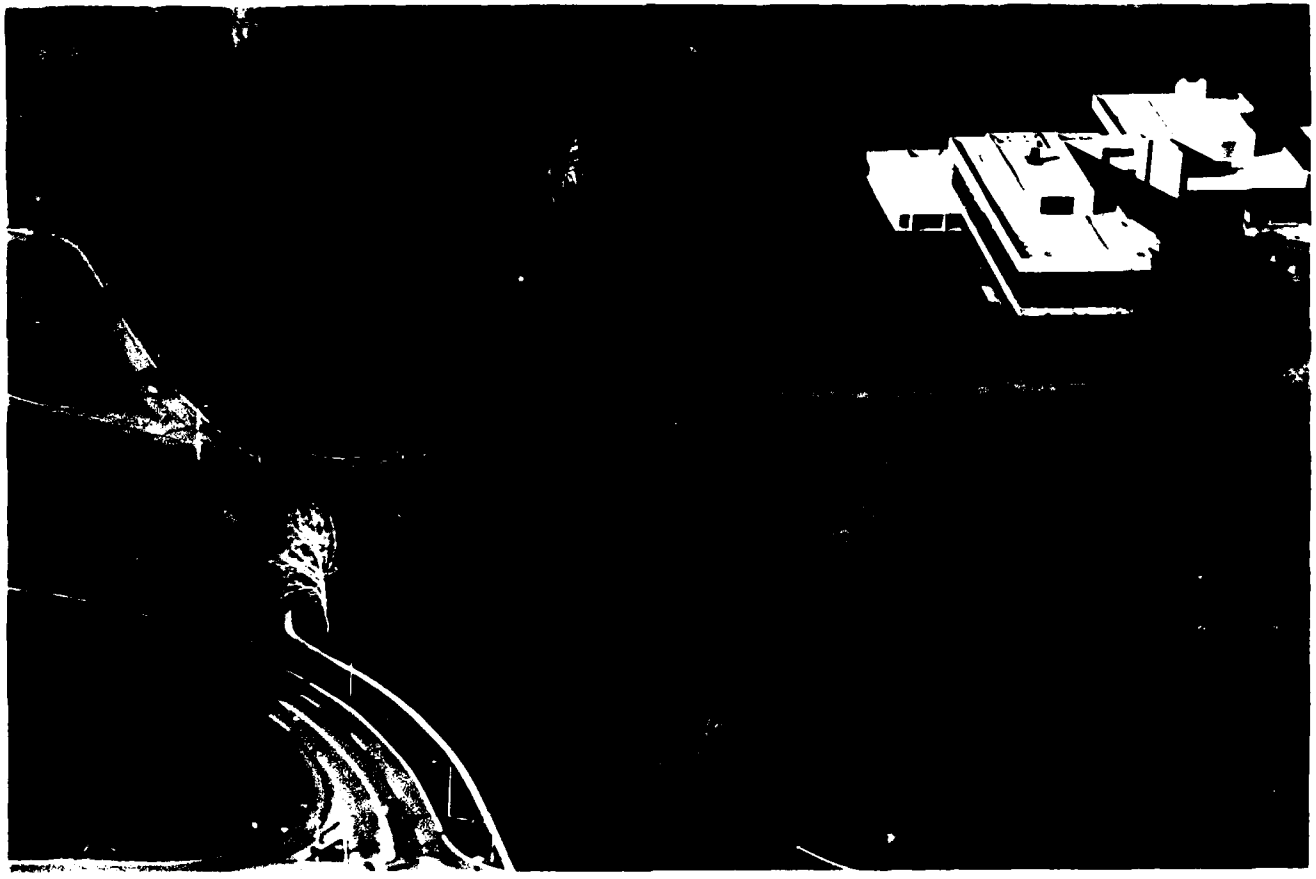
3) The animal hole and erosion gully on the downstream side of the dam should be filled and sodded.

4) The spillway discharge channel should be renovated to increase its capacity and prevent overflow.

In the near future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to insure the safety of the dam.

Richard J. McDermott, P.E.

John E. Gribbin, P.E.



OVERVIEW - DE COZEN'S DAM

29 NOVEMBER 1979

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## TABLE OF CONTENTS (cont.)

## PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that the unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DECOZEN'S DAM, I.D. NJ00353

## SECTION 1: PROJECT INFORMATION

### 1.1 General

a. Authority

Public Law 92-367, August 8, 1972 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The Division of Water Resources of the New Jersey Department of Environmental Protection (NJDEP) in cooperation with the Philadelphia District of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the State of New Jersey. Storch Engineers has been retained by the NJDEP to inspect and report on a selected group of these dams. The NJDEP is under agreement with the Philadelphia District of the Corps of Engineers.

b. Purpose of Inspection

The visual inspection of DeCozen's Dam was made on November 14, 1979 and March 21, 1980. The purpose of the inspection was to make a general assessment of the structural integrity and operational adequacy of the dam structure and its appurtenances.

## 1.2 Description of Project

### a. Description of Dam and Appurtenances

DeCozen's Dam is a rock fill embankment with a concrete chute-type spillway and a stone masonry wall located along its upstream side.

A paved walkway is located along the embankment crest which is oriented in a north-south direction. The upstream face consists of a concrete capped stone masonry wall for the majority of its length, the remainder of which consists of a concrete wall.

The spillway is located at the left, or north, end of the dam and consists of a concrete lined channel across the crest and extending approximately 20 feet down the natural slope adjacent to the left end of the dam. At the end of the concrete channel, an earth channel conveys discharge to a small lake located immediately downstream from the subject dam. A timber walkway spans the spillway at the dam crest.

The outlet works is located immediately south of the spillway and consists of a cut through the embankment lined with stone masonry and concrete abutments or training walls. The outlet is regulated by timber stoplogs. The discharge channel consists of a concrete lined channel containing concrete baffle-like obstructions. A timber walkway spans the outlet opening at the dam crest.

The dam has an overall length of 250 feet and a crest elevation of 327.4, National Geodetic Vertical Datum (N.G.V.D.). The dam crest is taken to be the top of the wall forming the

upstream face of dam. The elevation of the spillway crest is 325.7 while that of the outlet discharge channel bottom is 316.5. The height of dam is 10.9 feet.

b. Location

DeCozen's Dam is located on property of the Interpace Corporation office complex in the Township of Parsippany-Troy Hills. The dam is readily accessible by internal roads of the office complex.

c. Size and Hazard Classification

Size and Hazard Classification criteria presented in "Recommended Guidelines for Safety Inspection of Dams," published by the U.S. Army Corps of Engineers are as follows:

SIZE CLASSIFICATION

| | Impoundment | |
|---|---|---|
| | Storage (Ac-ft) | Height (Ft.) |
| Small | $<1000$ and $\geq 50$ | $<40$ and $\geq 25$ |
| Intermediate | $\geq 1000$ and $<50,000$ | $\geq 40$ and $<100$ |
| Large | $\geq 50,000$ | $\geq 100$ |

HAZARD POTENTIAL CLASSIFICATION

| Category | Loss of Life (Extent of Development) | Economic Loss (Extent of Development) |
|---|---|---|
| Low | None expected (no permanent structures for human habitation | Minimal (Undeveloped to to occasional structures or agriculture) |
| Significant | Few (No urban developments and no more than a small number of inhabitable structures | Appreciable (Notable agriculture, industry or structures) |
| High | More than a small number | Excessive (Extensive community, industry or agriculture) |

The following data relating to size and downstream hazard for DeCozen's Dam have been obtained for this Phase I report:

Storage: 51 Acre-feet

Height: 10.9 feet

Potential Loss of Life:

A heavily travelled road, Cherry Hill Road, is located downstream from the dam. Across Cherry Hill Road an office building and parking area are located in the flood plain of the dam. Failure of the dam could possibly cause loss of life.

Potential Economic Loss:

Cherry Hill Road and the downstream office building as well as cars in its parking area could sustain damage as a result of failure of the dam.

Therefore, DeCozen's Dam is classified as "Small" size and "Significant" hazard potential.

d. Ownership

DeCozen's Dam is owned and maintained by the Interpace Corporation, Cherry Hill Road, Parsippany-Troy Hills, N. J. Telephone 201-335-1111.

e. Purpose of Dam

The purpose of the dam is the impoundment of a lake used for recreation and aesthetics.

f. Design and Construction History

DeCozen's Dam reportedly was designed in 1954. However, no information concerning the design or construction is available.

g. Normal Operational Procedures

The dam and appurtenances are maintained by the maintenance crew of Interpace Corp. There is no fixed schedule of maintenance; repairs are made as the need arises.

The maintenance department reports that normally before every major storm stoplogs are pulled to provide more retention capacity. It is also reported that the dam has not been overtopped during the last ten years.

## 1.3 Pertinent Data

| | |
|---|---|
| a. Drainage Area | 0.4 Sq. Miles |
| b. Drainage at Damsite | |
| Maximum flood at damsite | Unknown |
| Outlet works at normal pool elevation | 48 c.f.s. |
| Spillway capacity at top of dam | 50 c.f.s. |
| c. Elevation (feet above MSL) | |
| Top of dam | 327.4 |
| Maximum pool-design surcharge | 328.7 |
| Normal pool | 325.9 |
| Spillway crest | 325.7 |
| Discharge channel invert | 316.5 |

d. Reservoir

| | |
|---|---|
| Length of maximum pool | 1400 feet (Estimated) |
| Length of normal pool | 1200 feet (Scaled) |

e. Storage (Acre-feet)

| | |
|---|---|
| Spillway crest | 38 Acre-feet |
| Design surcharge | 63 Acre-feet |
| Top of dam | 51 Acre-feet |

f. Reservoir Surface (Acres)

| | |
|---|---|
| Spillway crest | 10.0 Acres |
| Top of dam | 11.7 Acres |
| Maximum pool - design surcharge | 13.1Acres |

g. Dam

| | |
|---|---|
| Type | Rockfill (Reportedly) |
| Length | 250 feet |
| Height | 10.9 feet |
| Side slopes | |
| Embankment - Upstream | 3 horiz. to 1 vert. |
| - Downstream | 3 horiz. to 1 vert. |
| Zoning | Unknown |
| Impervious core | Stone masonry on upstream side of embankment |
| Cutoff | Unknown |
| Grout curtain | Unknown |

h. Diversion and Regulating Tunnel N.A.

i. Spillway

| | |
|---|---|
| Type | Uncontrolled concrete chute |
| Width of control section | 9 feet |
| Crest elevation | 325.7 |
| Gates | N.A. |
| Upstream channel | N.A. |
| Downstream channel | Earth channel discharging into downstream lake |

j. Outlet Works (Functioning as auxiliary spillway)

| | |
|---|---|
| Type | Sharp crested weir |
| Width | 3.9 feet |
| Crest elevation | 325.9 |
| Gates | Stoplogs form weir |
| Upstream channel | N.A. |
| Downstream channel | Concrete channel discharging into downstream lake |

k. Regulating Outlets

Timber stoplogs between 2 stone masonry and concrete abutments or training walls in cut through embankment.

## SECTION 2: ENGINEERING DATA

### 2.1 Design

No calculations, reports or plans pertaining to the design of the dam are available.

### 2.2 Construction

No data or reports pertaining to the construction of the dam are available.

### 2.3 Operation

No data pertaining to the operation of the dam are available.

### 2.4 Evaluation

a. Availability

No engineering information pertaining to the dam is available.

b. Adequacy

Available data is not adequate to be of significant assistance to the performance of a Phase I evaluation. A list of absent information is included in paragraph 7.1.b.

c. Validity

The validity of engineering data cannot be assessed due to the absence of data.

## SECTION 3: VISUAL INSPECTION

### 3.1 Findings

a. General

The inspection of DeCozen's Lake Dam took place on November 14, 1979 and March 21, 1980 by members of the staff of Storch Engineers. A copy of the visual inspection check list is contained in Appendix 1. The following procedures were employed for the inspection:

1) The embankment of the dam, appurtenant structures and adjacent areas were examined.
2) Areas of suspected seepage were noted and located.
3) The embankment and appurtenant structures were measured and key elevations determined by the use of a surveyor's level.
4) The embankment and appurtenant structures and adjacent areas were photographed.
5) Depths of water were measured at various locations in the lake.

b. Embankment

The paved walkway on the crest was in generally good condition. The stone masonry wall along the upstream face was in generally satisfactory condition except at two points where the concrete cap was broken and the top of wall deteriorated. Two areas of seepage were noted on the downstream side of the dam. The downstream face was very wet and soft near the toe at the approximate center of the dam and a small area of standing water was observed immediately downstream from the toe about midway between the center and the north end of the dam.

On March 21, 1980, during a storm, leakage was observed discharging from the junction between the left training wall of the outlet works and the downstream side of the embankment. The lake stage was approximately 0.5' above the spillway crest. The leakage was discharging as a trickle.

The downstream face was covered with a stand of cut grass and some small trees were located along the crest. The top of a stone masonry wall was exposed at various locations along the downstream side of the crest. The full extent of the wall could not be determined at the time of inspection. One animal hole was observed on the downstream face.

A ditch or gully was observed on the downstream face running from the spillway to the outlet works discharge channel. The gully appeared to be the result of overflow from the spillway or overtopping of the dam. On March 21, 1980, during a storm, the spillway discharge channel was overflowing into the gully.

Riprap was observed along the sloped upstream face, adjacent to the stone masonry wall. The stones appeared to be of adequate size.

c. Spillway and Outlet

Concrete surfaces in the spillway chute appeared to be in satisfactory condition. The stone masonry headwalls at the upstream end of the spillway and outlet structures were generally in good condition.

The concrete bottom portions of the outlet works training walls appeared to be in satisfactory condition. The stone masonry portions appeared to be sound but some deterioration

in the form of dislodged stones was noted. The concrete cap was significantly spalled around its edges. Concrete surfaces in the outlet channel were in satisfactory condition.

The downstream surface of the set of timber stoplogs appeared to be in satisfactory condition. The timber walkways spanning the spillway and outlet works were in satisfactory condition.

d. Reservoir Area

The shores of the lake are grass covered at the east end and tree lined at the west end. Slopes are generally moderate. Soundings in the lake in the vicinity of the outlet works indicated little accumulation of sediment.

e. Downstream Area

Immediately downstream from the dam lies a small lake into which the downstream channel discharges. A heavily travelled public road (Cherry Hill Road) is located immediately downstream from the second lake. Beyond the road, flow from the downstream channel is conveyed by a 10-foot diameter corrugated metal pipe. A large office building and parking area are located downstream from the road.

## SECTION 4: OPERATIONAL PROCEDURES

### 4.1 Procedures

The level of water in the impoundment of DeCozen's Dam is regulated naturally by discharge over the concrete spillway and timber stoplogs of the outlet works. Reportedly, the stoplogs are pulled at the time of intense storms to augment the spillway and to increase retention capacity.

The timber stoplogs are also pulled to lower the lake to facilitate maintenance operations. Reportedly, in 1970 the lake was lowered three-quarters of its full depth for maintenance purposes and since then the lake has been lowered 8 inches each year for lake maintenance.

### 4.2 Maintenance of the Dam

Reportedly, the only program of regular maintenance of the dam and appurtenant structures is the mowing of grass and the removal of weeds. Other maintenance is performed on an "as needed" basis by Interpace Corp.

The most recent maintenance was repair to the concrete at the outlet works and the spillway in 1970.

### 4.3 Description of Warning System

Reportedly, no formal warning system is in use at the present time.

### 4.4 Evaluation of Operation Adequacy

Maintenance documentation is poor; however the general condition of the dam indicates that maintenance has been generally adequate.

Maintenance of the dam appears to be insufficient in the following areas:

1) Concrete cap on upstream stone masonry wall was broken.
2) Erosion gully not filled and stabilized.
3) Animal hole not filled.

Operation of the dam during storms reportedly has been successful in preventing overtopping of the embankment.

## SECTION 5: HYDRAULIC/HYDROLOGIC

### 5.1 Evaluation of Features

a. Design Data

The quantity of storm water runoff that the spillway should be able to pass without an overtopping of the dam is based on the size and hazard classification of the dam. This runoff, called the Spillway Design Flood (SDF), is described in terms of frequency or probable maximum flood (PMF) depending on the extent of the dam's size and potential hazard. According to the "Recommended Guidelines for Safety Inspection of Dams," published by the U.S. Army Corps of Engineers, the SDF for DeCozen's Dam falls in a range of 100-year frequency to 1/2 PMF. In this case the high end of the range, 1/2 PMF, is chosen because of the hazard potential resulting from the road and office building downstream from the dam.

The SDF hydrograph for DeCozen's Lake was computed by the HEC-1-DB computer program using the Soil Conservation Service triangular unit hydrograph with the curvilinear transformation. Hydrologic computations and computer output are contained in Appendix 4. The calculated SDF peak inflow for DeCozen's Dam is 1047 c.f.s.

Discharge capacity for the spillway was computed by considering free discharge through the spillway chute and over the stoplogs of the outlet works. Hydraulic computations are contained in Appendix 4.

The SDF was routed through the dam by the use of the HEC-1-DB computer program using the modified Puls method. In routing the SDF, it was found that the dam would be

overtopped to a depth of 1.3 feet. Accordingly, the subject spillway is assessed as being inadequate in accordance with criteria developed by the U.S. Army Corps of Engineers.

b. Experience Data

The maintenance department of Interpace Corp. reported that the dam has not been overtopped due to high lake water level during the last 10 years. No experience data relating to the period preceding the past 10 years could be obtained.

c. Visual Observations

A gully was observed on the downstream side of the dam in the vicinity of the spillway. Based on observations made during a storm the gully has apparently been formed by overflowing of the spillway discharge channel.

d. Overtopping Potential

As indicated in paragraph 5.1.a, a storm of magnitude equivalent to the SDF would cause overtopping of the dam by a depth of 1.3 feet above the top of dam. The spillway is capable of passing approximately 4 percent of the PMF or 8 percent of the SDF with lake level equal to the top of dam (elev. 227.4).

## SECTION 6: STRUCTURAL STABILITY

### 6.1 Evaluation of Structural Stability

a. Visual Observations

The embankment appeared at the time of inspection to be outwardly stable. However, two areas of suspected seepage were observed at the toe. The effect of the observed seepage on the structural stability of the dam cannot be assessed with the information available for this Phase I study. However, the seepage does not appear to indicate immediate embankment instability.

b. Generalized Soils Description

The generalized soils description of the dam site consists of recent alluvium composed of stratified materials deposited by streams overlying glacial quaternary deposits. The quaternary deposits consist of a thin layer of glacial stratified drift overlying a thicker layer of glacial ground moraine. The stratified drift is composed of silty sands, silty gravels, sandy gravels and gravelly sands. The quaternary deposits overly soft red shale bedrock identified as the Brunswick Formation.

c. Design and Construction Data

Analysis of structural stability and construction data for the embankment and spillway structure are not available.

d. Operating Records

No operating records are available for the dam.

e. Post Construction Changes

According to the maintenance department of Interpace Corp., the extension of the masonry wall on the upstream side of the south end of the dam in 1970 was the only post construction change.

f. Seismic Stability

DeCozen's Dam is located in Seismic Zone 1 is defined in "Recommended Guideline for Safety Inspection of Dams," which is a zone of very low seismic activity. Experience indicates that dams in Seismic Zone 1 will have adequate stability under seismic loading conditions if stable under static loading conditions. DeCozen's Dam appeared to be outwardly stable under seismic loading conditions at the time of inspection.

## SECTION 7: ASSESSMENT AND RECOMMENDATIONS

### 7.1 Dam Assessment

a. Safety

Based on hydraulic and hydrologic analyses outlined in Section 5 and Appendix 4, the spillway of Decozen's Dam is assessed as being inadequate.

The dam appeared, at the time of inspection, to be generally outwardly stable. Two areas of seepage were observed on the downstream side of the dam near the toe. However, the observed seepage does not appear to be an indication of immediate embankment instability.

b. Adequacy of Information

Information sources for this study include: 1) field inspection, 2) USGS quadrangle, 3) aerial photography and 4) consultation with representatives of Interpace Corp. The information outlined is sufficient to allow a Phase I assessment as outlined in "Recommended Guidelines for Safety Inspection of Dams."

Some of the absent data are as follows:

1) Soils Report
2) Construction drawings and as-built plans
3) Structural Design Report
4) Hydraulic Design Report
5) Maintenance Documentation

c. Necessity for Additional Data/Evaluation

Although some data pertaining to DeCozen's Dam are not available, additional data are not considered imperative for this Phase I evaluation.

## 7.2 Recommendations

a. Remedial Measures

Based on hydraulic and hydrologic analyses outlined in paragraph 5.1.a., the spillway is assessed as being inadequate. It is therefore recommended that a professional engineer experienced in the design and construction of dams be engaged in the future to perform more accurate hydraulic and hydrologic analyses. Based on the findings of the analyses, the need for and type of remedial measures should be determined and then implemented.

Two areas of seepage were observed at the toe of dam. Arrangements should be made in the near future to monitor the seepage on a monthly basis in order to detect any changes in its condition. The monitoring should be performed by a professional engineer experienced in the design and construction of dams.

In addition, it is recommended that the following remedial measures be undertaken by the owner in the future:

1) With the lake drawn down, the concrete spillway and outlet structure should be thoroughly inspected by a professional engineer experienced in the design and construction of dams. Based on the inspection, any necessary remedial measures should

be determined and then implemented. Also, the outlet structure should be repaired to prevent leakage during times of high lake stage.

2) All trees on the embankment should be removed.
3) The animal hole and erosion gully or the downstream side of the dam should be filled and sodded.
4) The spillway discharge channel should be renovated to increase its capacity and prevent overflow.

b) Maintenance

In the near future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to insure the safety of the dam.

# PLATES

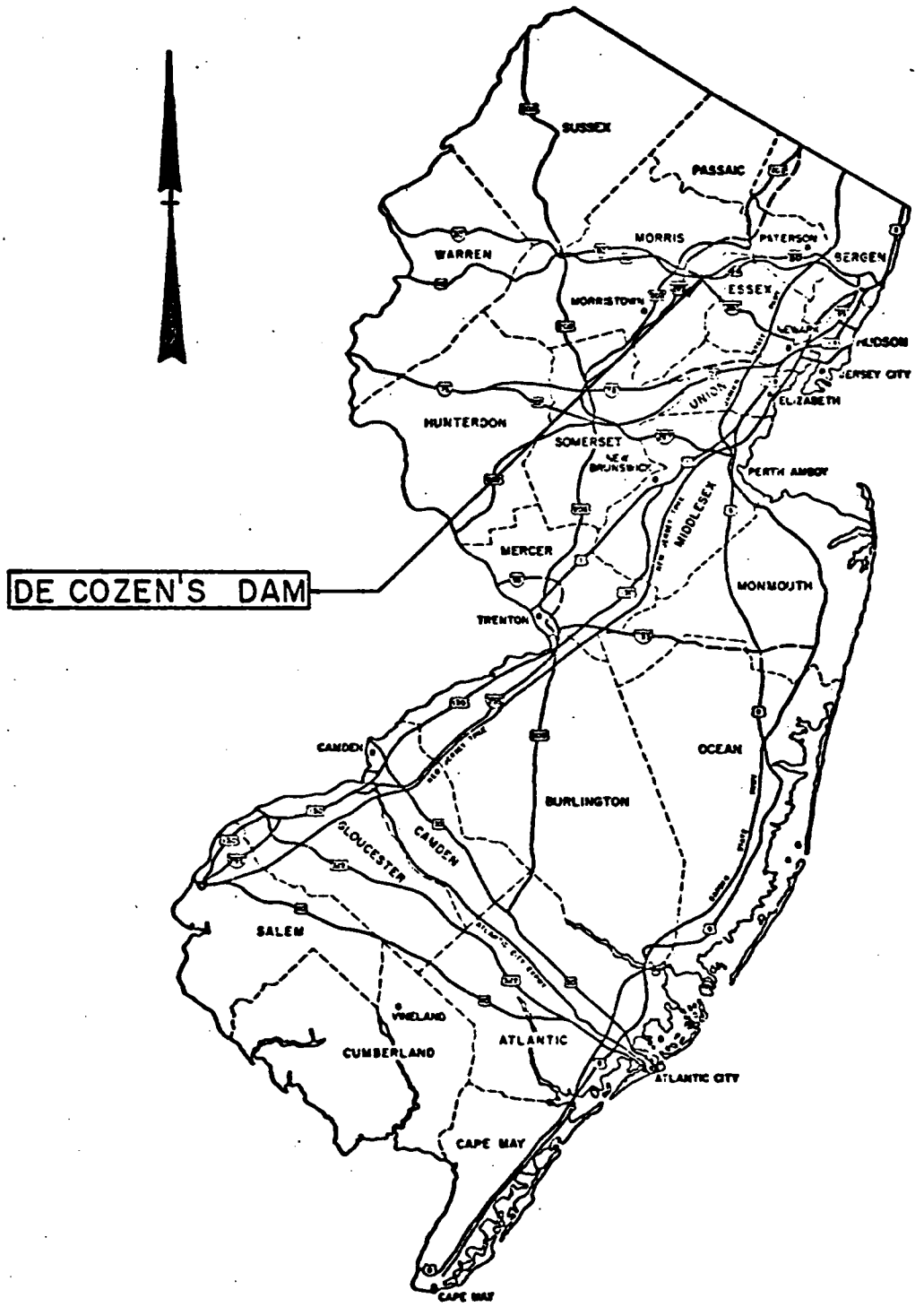
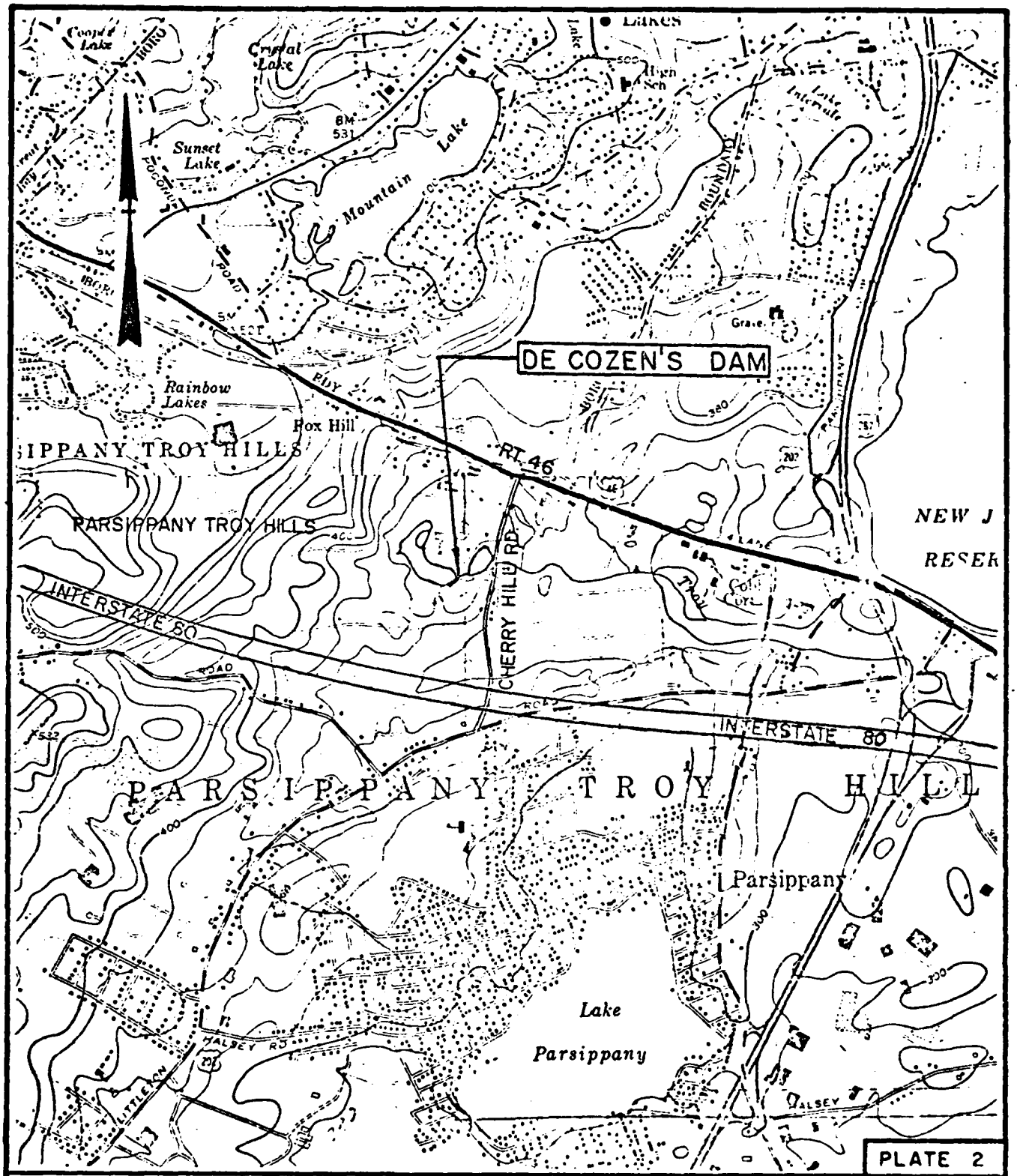
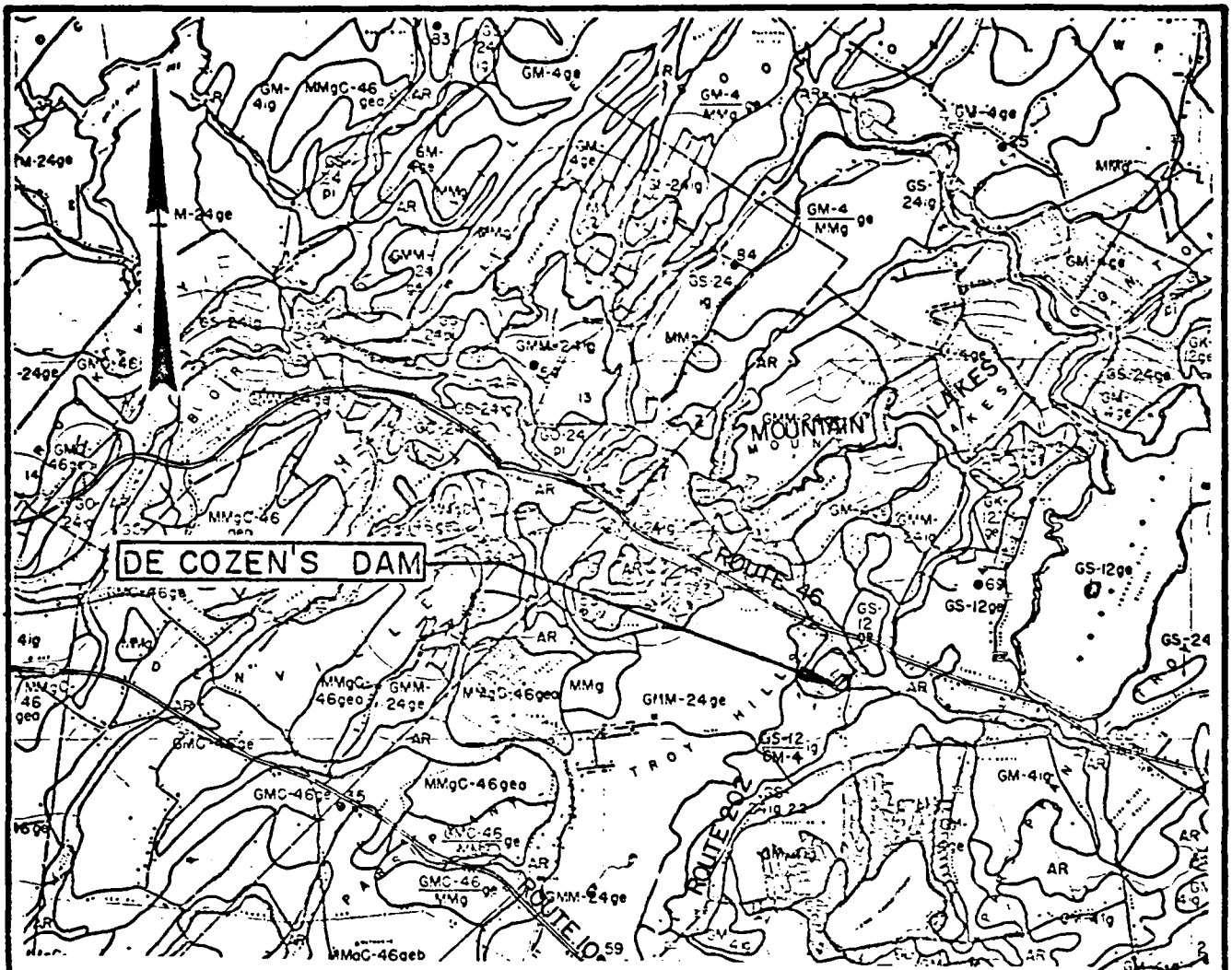



PLATE 1

| | |
|---|---|
| STORCH ENGINEERS<br>FLORHAM PARK, NEW JERSEY | INSPECTION AND EVALUATION OF DAMS<br>KEY MAP<br>DE COZEN'S DAM |
| DIVISION OF WATER RESOURCES<br>N.J. DEPT. OF ENVIR. PROTECTION<br>TRENTON, NEW JERSEY | I. D. N.J. 00353 — SCALE: NONE<br>DATE: NOV., 1979 |




| | |
|---|---|
| STORCH ENGINEERS<br>FLORHAM PARK, NEW JERSEY | INSPECTION AND EVALUATION OF DAMS<br>VICINITY MAP<br>DE COZEN'S DAM |
| DIVISION OF WATER RESOURCES<br>N.J. DEPT. OF ENVIR. PROTECTION<br>TRENTON, NEW JERSEY | I. D. N.J. 00353 — SCALE: AS SHOWN<br>DATE: NOV., 1979 |



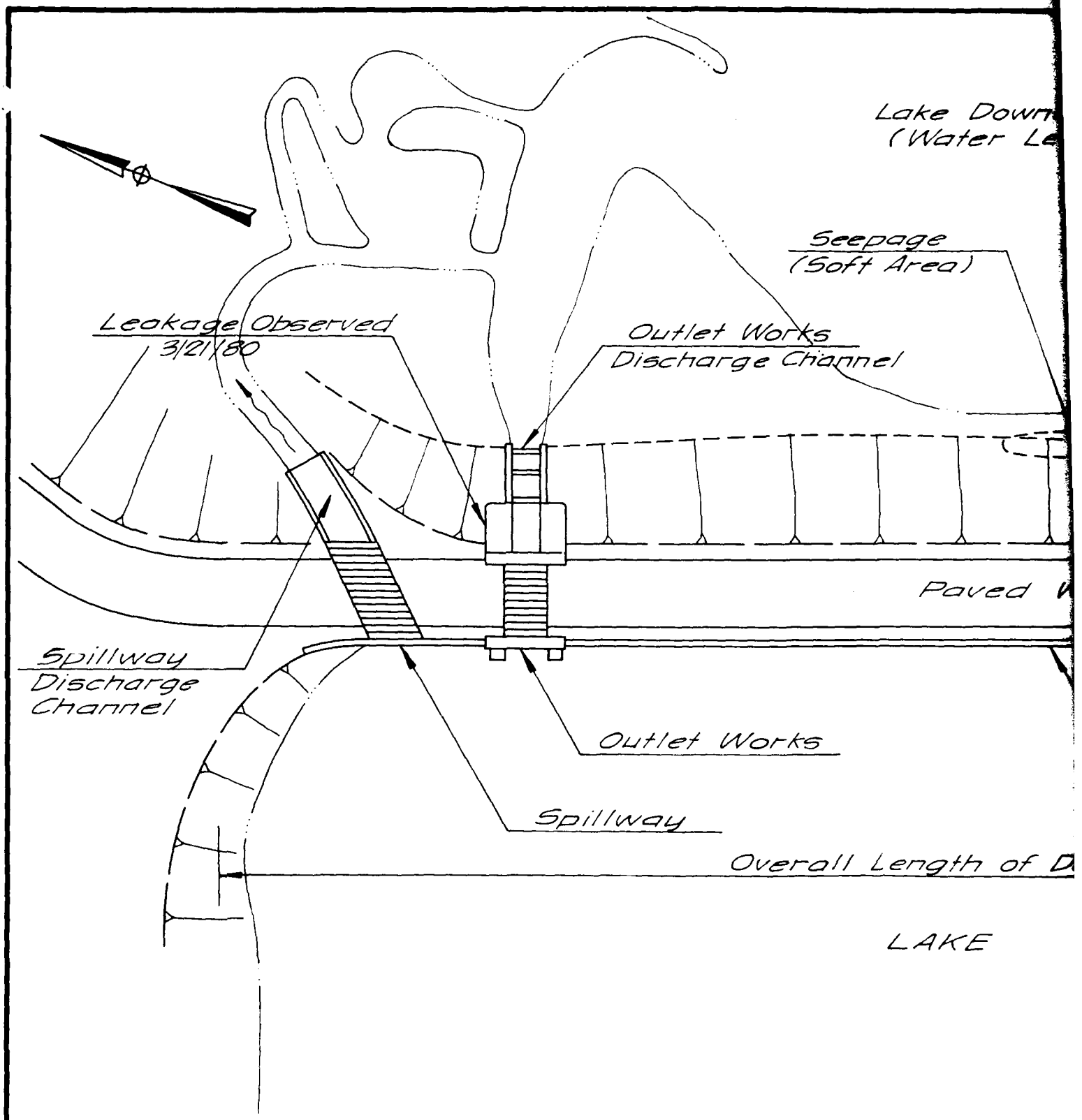

Legend

| | |
|---|---|
| AR | Recent alluvium composed of stratified materials deposited by streams. |
| GS-12 | Glacial stratified drift deposited by melt waters flowing from the Wisconsin glacier composed of silty sands, silty gravels, sandy gravels and gravelly sands. |
| GM-4 | Glacial ground moraine composed of silts and silty sands deposited during the Wisconsin glaciation. |

NOTE: Information taken from Rutgers University Soil Survey of New Jersey, Report No. 9, Morris County, and Geologic Map of New Jersey prepared by Lewis and Kummel.

PLATE 3

| | |
|---|---|
| STORCH ENGINEERS<br>FLORHAM PARK, NEW JERSEY | INSPECTION AND EVALUATION OF DAMS<br>SOIL MAP<br>DE COZEN'S DAM |
| DIVISION OF WATER RESOURCES<br>N.J. DEPT. OF ENVIR. PROTECTION<br>TRENTON, NEW JERSEY | I.D. NJ 00353 / SCALE: NONE<br>DATE: NOV., 1979 |




Note:
Information taken from field inspection November 14, 1979. and March 21, 1980.

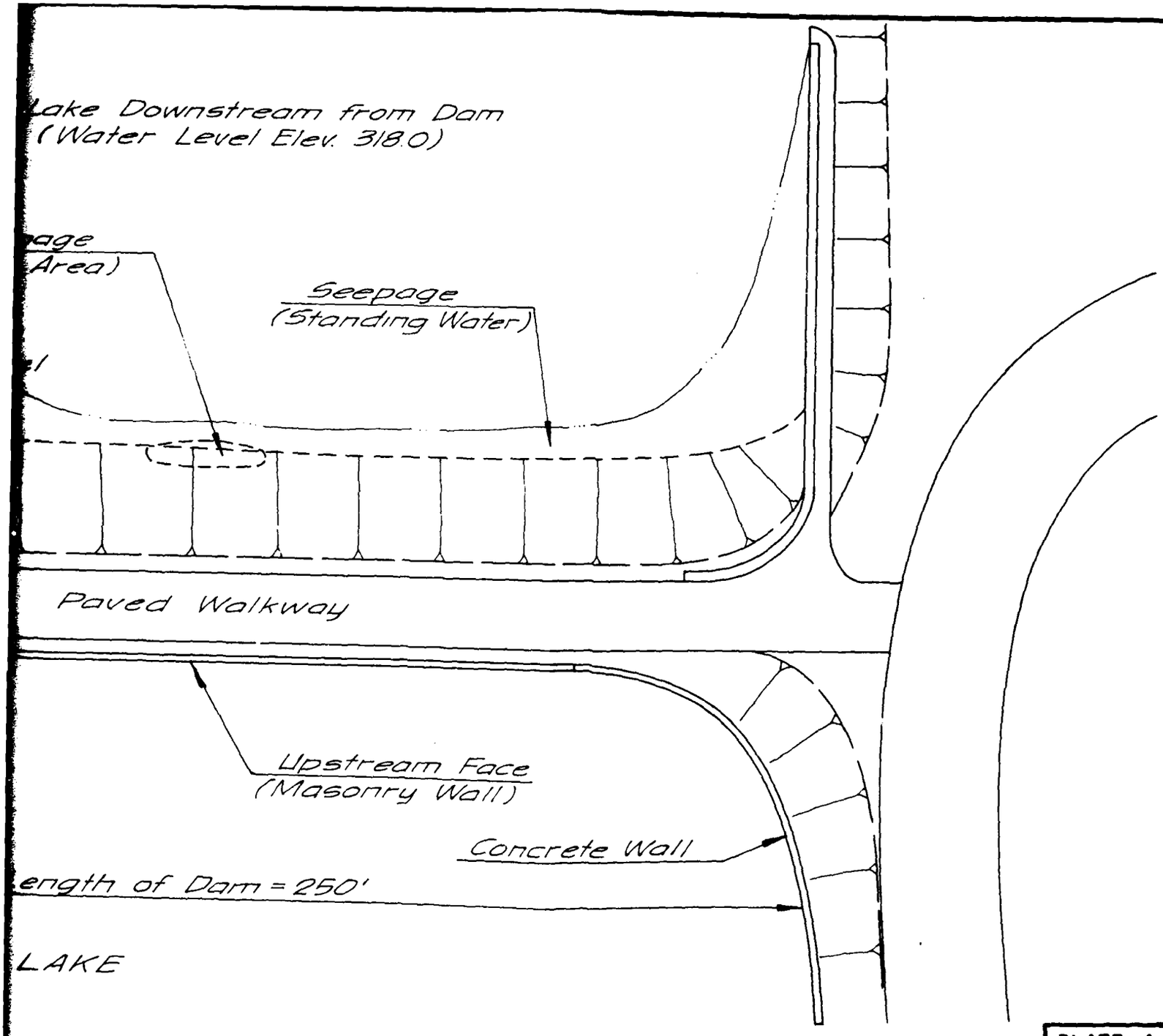



PLATE 4

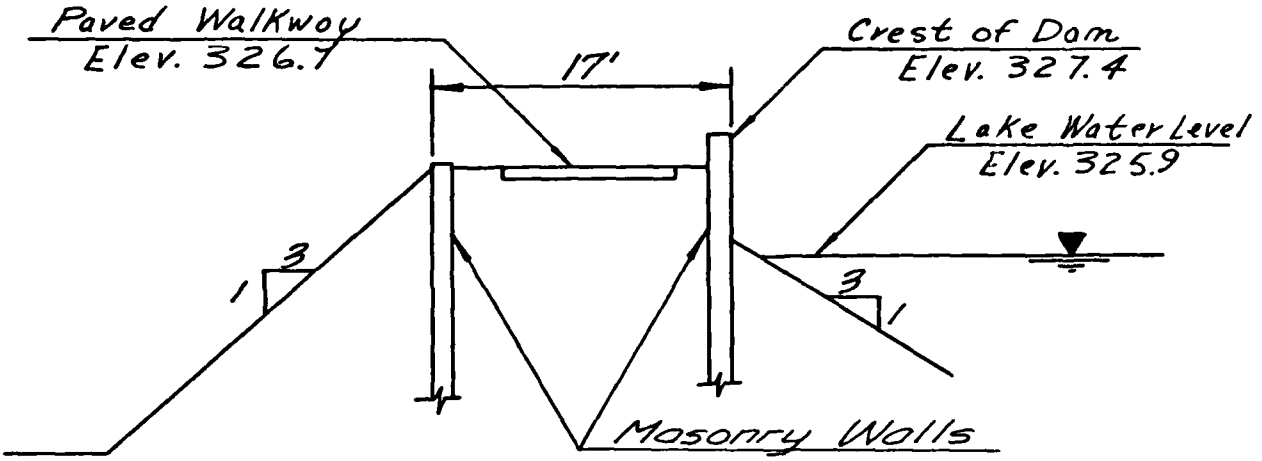
| | |
|---|---|
| STORCH ENGINEERS<br>FLORHAM PARK, NEW JERSEY | DIVISION OF WATER RESOURCES<br>N.J. DEPT. OF ENVIR. PROTECTION<br>TRENTON, NEW JERSEY |

INSPECTION AND EVALUATION OF DAMS

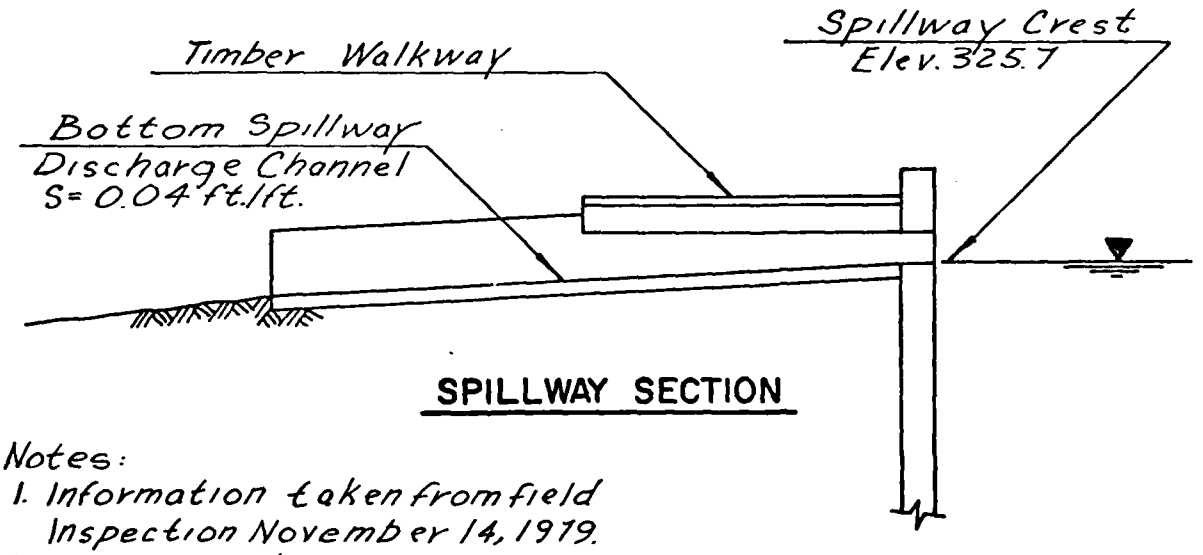
# GENERAL PLAN

DE COZEN'S DAM

| | |
|---|---|
| I.D.N.J. 00353 | SCALE: NOT TO SCALE |
| | DATE: DEC. 1979 |




DAM SECTION

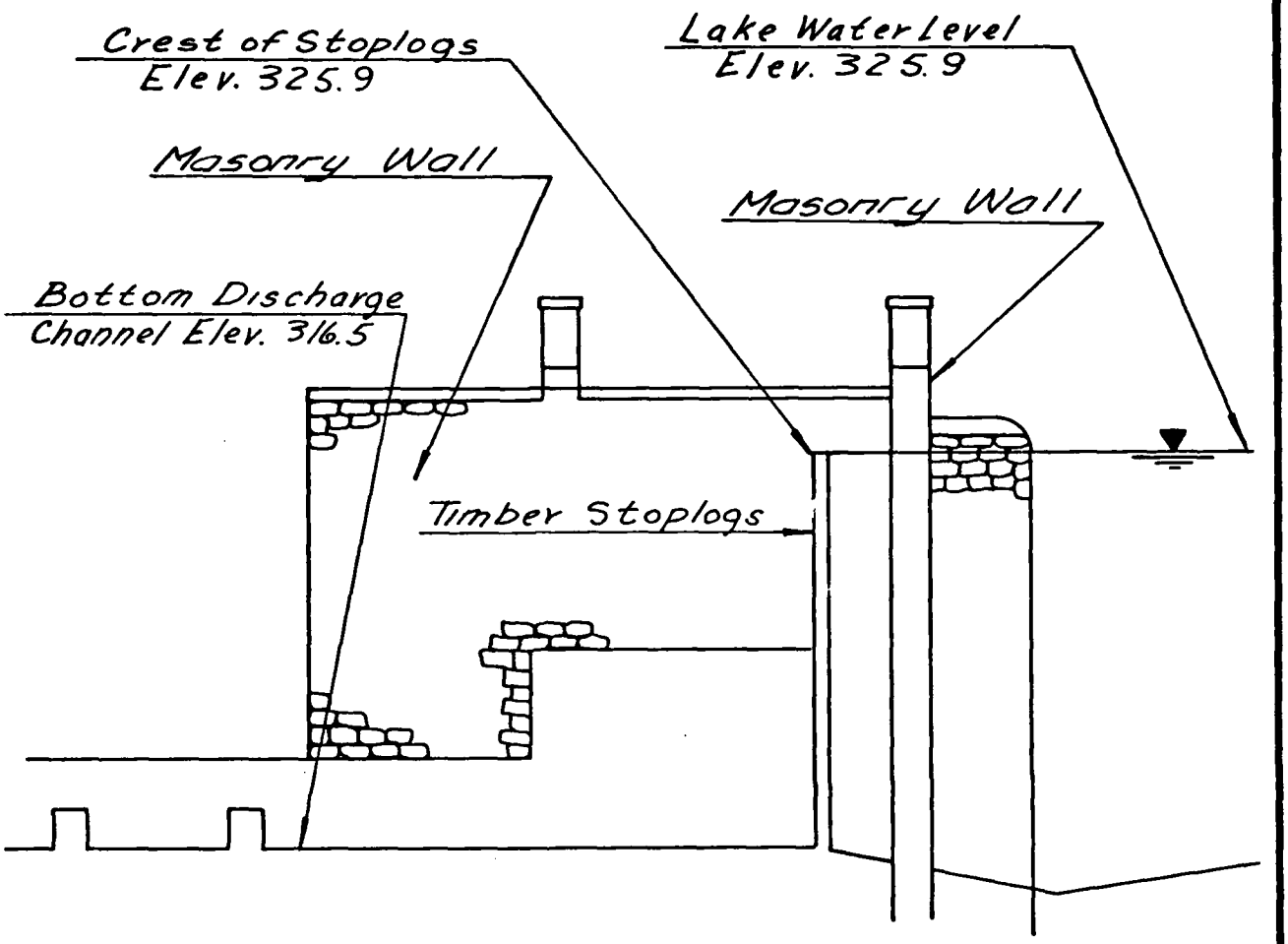



SPILLWAY SECTION

Notes:
1. Information taken from field Inspection November 14, 1979.
2. Elevations based on NGVD taken from Twp. of Parsippany Municipal Aerial Topography.

PLATE 5

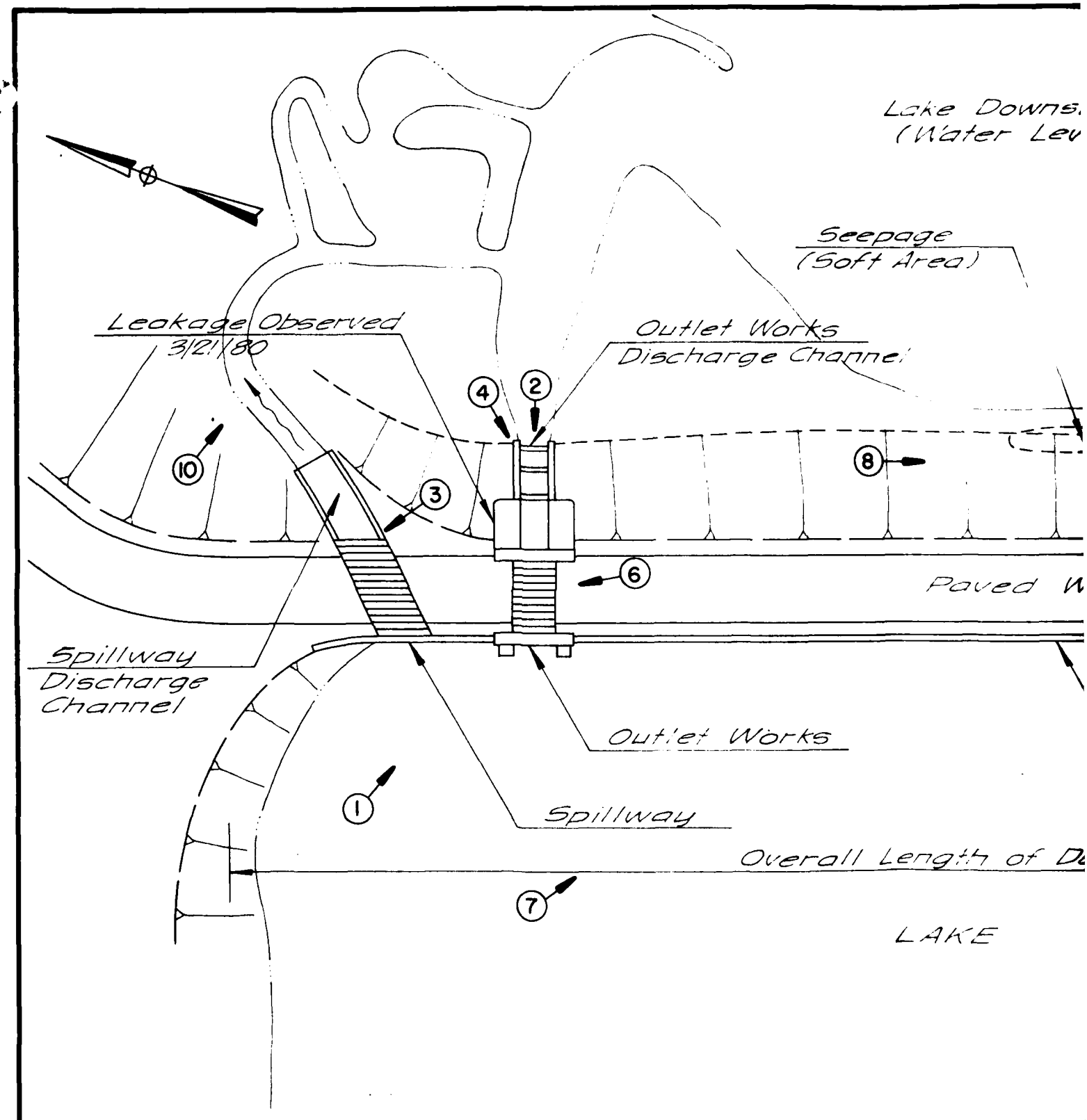
| | |
|---|---|
| STORCH ENGINEERS<br>FLORHAM PARK, NEW JERSEY | INSPECTION AND EVALUATION OF DAMS<br>TYPICAL SECTIONS<br>DE COZEN'S DAM |
| DIVISION OF WATER RESOURCES<br>N.J. DEPT. OF ENVIR. PROTECTION<br>TRENTON, NEW JERSEY | I.D.N.J. 00353 — SCALE: NOT TO SCALE<br>DATE: DEC. 1979 |




Notes:
1. Information taken from field Inspection November 14, 1979.
2. Elevations based on NGVD Taken from Twp. of Parsippany Municipal Aerial Topography.

PLATE 6

| | |
|---|---|
| STORCH ENGINEERS<br>FLORHAM PARK, NEW JERSEY | INSPECTION AND EVALUATION OF DAMS<br>OUTLET WORKS SECTION<br>DE COZEN'S DAM |
| DIVISION OF WATER RESOURCES<br>N.J. DEPT. OF ENVIR. PROTECTION<br>TRENTON, NEW JERSEY | I.D.N.J. 00353 — SCALE: NOT TO SCALE<br>DATE: DEC. 1979 |




Note:
Information taken from field inspection November 14, 1979.

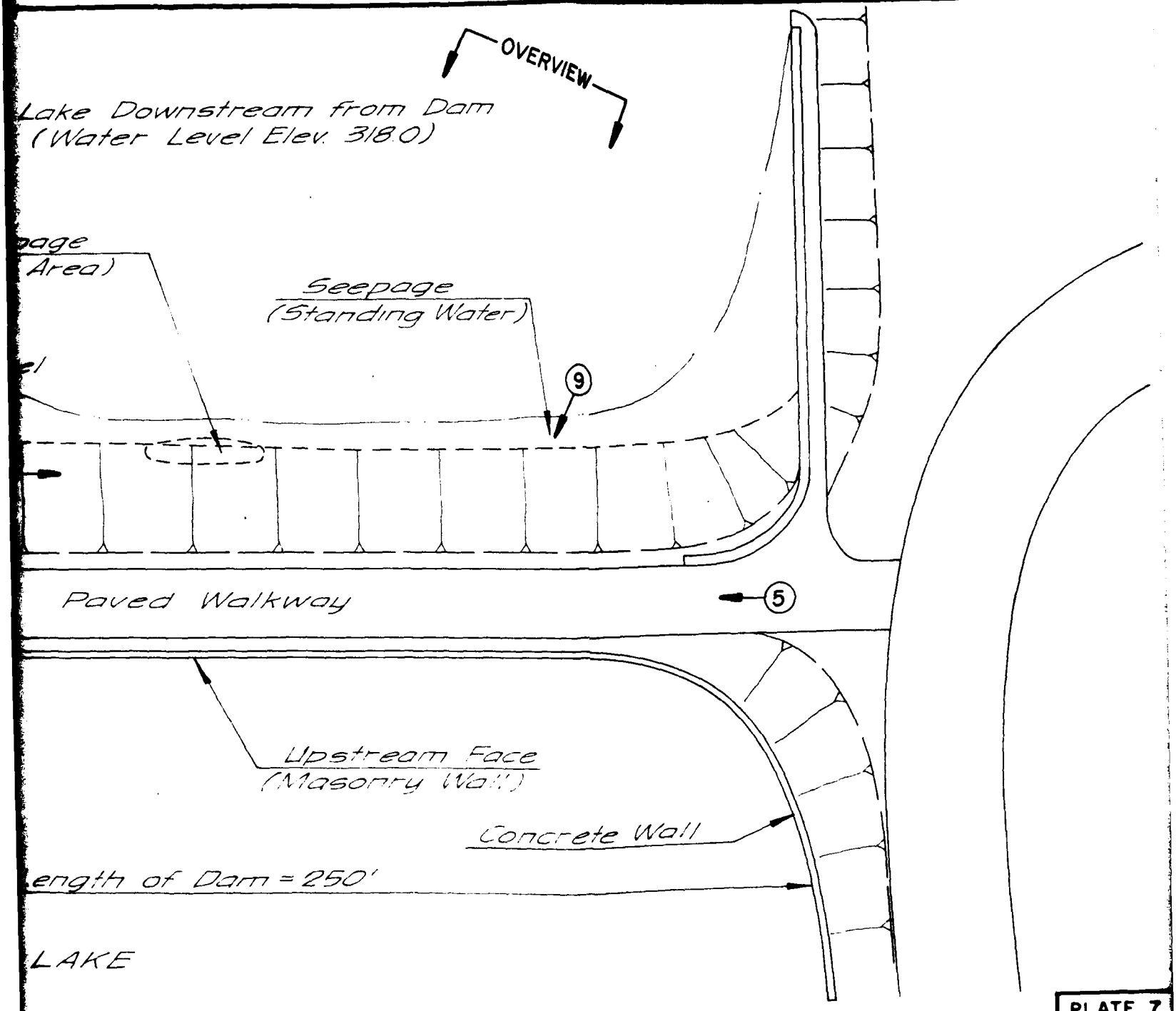



PLATE 7

| | |
|---|---|
| STORCH ENGINEERS<br>FLORHAM PARK, NEW JERSEY | DIVISION OF WATER RESOURCE<br>N.J. DEPT. OF ENVIR. PROTECTIO<br>TRENTON, NEW JERSEY |

INSPECTION AND EVALUATION OF DAMS

# PHOTO LOCATION PLAN

DE COZEN'S DAM

| | |
|---|---|
| I.D.N.J. 00353 | SCALE NOT TO SCALE |
| | DATE DEC. 1979 |

# APPENDIX 1

Check List - Visual Inspection
Check List - Engineering Data

# Check List
# Visual Inspection
# Phase I

**Name of Dam** DeCozen's Dam **County** Morris **State** New Jersey **Coordinators** NJDEP

**Date(s) Inspection** 11/14/79, 3/21/80 **Weather** Cloudy, Rain **Temperature** 45°F

**Pool Elevation at Time of Inspection** 325.9 M.S.L. **Tailwater at Time of Inspection** 318.0 M.S.L.

**Inspection Personnel:**

John Gribbin
Alan Volle
Ronald Lai
Thomas Miller
Richard McDermott
J. Gribbin **Recorder**

Present: Mr. Larry O'Rourke, Maintenance Supervisor, Interpace Corp. 11/14/79

## EMBANKMENT

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| GENERAL | Paved walkway in generally good condition is located on the crest. Downstream face covered with good stand of grass with small trees located along crest. The top of a stone masonry wall was exposed at some locations along the downstream side of the crest. One animal hole noted on downstream face. | Stone masonry wall could be corewall. |
| JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM | Junctions at abutments appeared to be sound. | |
| ANY NOTICEABLE SEEPAGE | Two areas of seepage were noted.<br>1. The downstream face was very wet and soft near the toe at the approx. mid-point of the dam.<br>2. A small puddle of standing water was noted immediately downstream from the toe about midway between the center and the north end of the dam. | One point of leakage was noted on 3/21/80: Water was discharging from the embankment adjacent to left training wall of the outlet works. Discharge was a trickle. Lake stage was approx. 0.5' above spillway crest. |
| UPSTREAM FACE | The stone masonry wall is in generally satisfactory condition although in two places its concrete cap was broken off. The concrete wall was in generally good condition. | A concrete capped stone masonry wall comprises the upper portion of the upstream face of dam for most of its length. A concrete wall forms the south portion of the upstream face. |
| DRAINS | None observed | |

## EMBANKMENT

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| SURFACE CRACKS | None observed | |
| UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE | None observed | |
| SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES | Ditch or gulley was observed running from downstream end of spillway across portion of embankment to outlet works discharge channel. Ditch appeared to be formed by overflow from spillway or overtopping of dam.<br>On 3/21/80, during storm, the discharge channel was overflowing into the ditch. | Recommend increasing discharge channel capacity. |
| VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST | Vertical: level<br>Horizontal: Straight | |
| RIPRAP | Riprap was observed along the upstream face, upstream from the stone masonry wall. The stones appeared to be of adequate size. | |

## OUTLET WORKS

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CONCRETE SURFACES IN OUTLET CONDUIT | N.A. | |
| INTAKE STRUCTURE | Stone masonry headwall at upstream end of outlet appeared to be in generally good condition. Concrete bottom portions of training walls appeared to be in satisfactory condition. Stone masonry portion appeared to be sound but some deterioration in the form of dislodged stones was noted. | Outlet works formed by stone masonry and concrete abutments or training walls constructed through earth embankment. |
| OUTLET STRUCTURE | Concrete cap was formed on top of downstream portion of training walls. Concrete cap was significantly spalled around the edges. | |
| OUTLET CHANNEL | Concrete outlet channel with rectangular section with a series of concrete weirs or baffles appeared to be in satisfactory condition. | |
| GATE AND GATE HOUSING | Downstream surface of timber stoplogs appeared to be in satisfactory condition.<br>Timber walkway spanning training walls at crest of dam appeared to be in satisfactory condition. | |

## SPILLWAY

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| ENTRANCE | Entrance to chute type spillway formed by opening in stone masonry wall on upstream face of dam. | |
| DISCHARGE CHANNEL | Discharge channel bottom formed by concrete slab across crest of dam and extending approx. 20 feet downstream from the crest. Slab appeared to be in satisfactory condition. Timber walkway spanning discharge channel at crest of dam was in satisfactory condition. | |
| | | |
| | | |
| | | |

## INSTRUMENTATION

| VISUAL EXAMINATION | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| MONUMENTATION/SURVEYS | None observed | |
| OBSERVATION WELLS | None observed | |
| WEIRS | None observed | |
| PIEZOMETERS | None observed | |
| OTHER | N.A. | |

## RESERVOIR

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| SLOPES | The shores of the lake are grass covered at the east end and tree lined at the west end. Slopes are generally moderate. | |
| SEDIMENTATION | Soundings in the lake in the vicinity of the outlet works indicated little accumulation of sediment. | |
| STRUCTURES ALONG BANKS | Two large office buildings are located within 200 feet of both the north and south shores of the lake. | |
| | | |
| | | |

## DOWNSTREAM CHANNEL

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CONDITION (OBSTRUCTIONS, DEBRIS, ETC.) | Downstream channel consists of a small, meandering, earth lined stream connecting the spillway with a lake immediately downstream from the dam. The stream separates into two branches each of which contains a small stone weir near its discharge into the downstream lake. | |
| SLOPES | Stream banks were grass lined and had moderate slopes. | |
| STRUCTURES ALONG BANKS | Heavily travelled public road located immediately downstream from lake located downstream from dam. Large office building located immediately downstream from road. Flow from the channel is conveyed by a 10' CMP downstream from the road. | |
| | | |
| | | |

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

| ITEM | | REMARKS |
|---|---|---|
| DAM - | PLAN | Not available |
| | SECTIONS | |
| SPILLWAY - | PLAN | Not available |
| | SECTIONS | |
| | DETAILS | |
| OPERATING EQUIPMENT PLANS & DETAILS | | Not available |
| OUTLETS - | PLAN | Not available |
| | DETAILS | |
| | CONSTRAINTS | |
| | DISCHARGE RATINGS | |
| HYDRAULIC/HYDROLOGIC DATA | | Reportedly, plan showing lake depths on file at Interpace Corp. |
| RAINFALL/RESERVOIR RECORDS | | Not available |
| CONSTRUCTION HISTORY | | Not available |
| LOCATION MAP | | Not available |

| ITEM | REMARKS |
|---|---|
| DESIGN REPORTS | Not available |
| GEOLOGY REPORTS | Not available |
| DESIGN COMPUTATIONS<br>HYDROLOGY & HYDRAULICS<br>DAM STABILITY<br>SEEPAGE STUDIES | Not available |
| MATERIALS INVESTIGATIONS<br>BORING RECORDS<br>LABORATORY<br>FIELD | Not available |
| POST-CONSTRUCTION SURVEYS OF DAM | Not available |
| BORROW SOURCES | Not available |

| ITEM | REMARKS |
|---|---|
| MONITORING SYSTEMS | Not Available |
| MODIFICATIONS | Not available |
| HIGH POOL RECORDS | Not available |
| POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS | Not available |
| PRIOR ACCIDENTS OR FAILURE OF DAM<br>DESCRIPTION<br>REPORTS | Not available |
| MAINTENANCE OPERATION RECORDS | Not available |

# APPENDIX 2

Photographs

PHOTO 1

ENTRANCES TO SPILLWAY AND OUTLET WORKS

PHOTO 2

DOWNSTREAM SIDE OF OUTLET WORKS SHOWING STOPLOGS

DE COZEN'S DAM
14 NOVEMBER 1979

PHOTO 3

SPILLWAY DISCHARGE

PHOTO 4

OUTLET WORKS DISCHARGE

DE COZEN'S DAM
14 NOVEMBER 1979

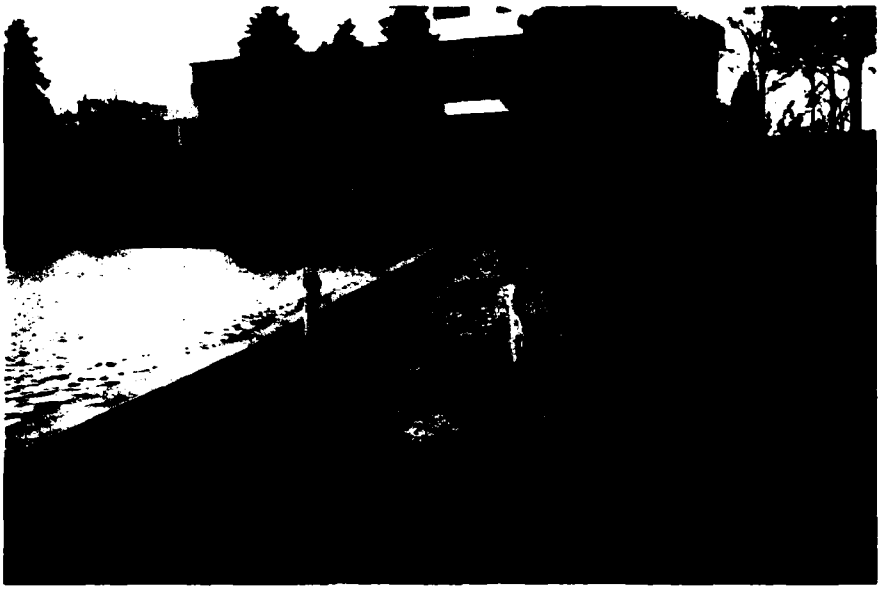


PHOTO 5

CREST OF DAM

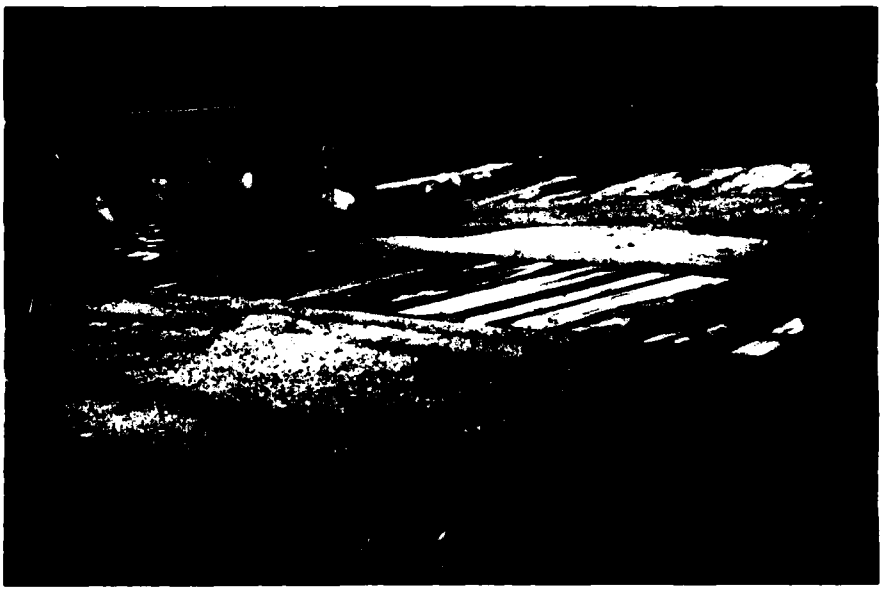


PHOTO 6

TIMBER WALKWAYS OVER OUTLET WORKS AND SPILLWAY

DE COZEN'S DAM
14 NOVEMBER 1979

PHOTO 7

UPSTREAM FACE OF DAM

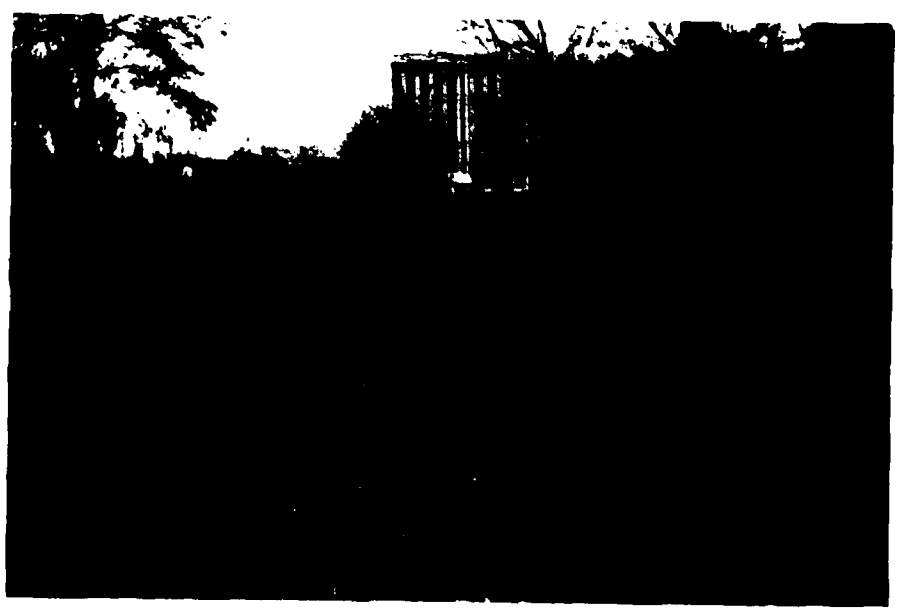


PHOTO 8

DOWNSTREAM FACE OF DAM

DE COZEN'S DAM
14 NOVEMBER 1979

PHOTO 9

SEEPAGE AT TOE OF DAM

PHOTO 10

SPILLWAY DISCHARGE CHANNEL

DE COZEN'S DAM
14 NOVEMBER 1979

# APPENDIX 3

Engineering Data

CHECK LIST

HYDROLOGIC AND HYDRAULIC DATA

ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Partly wooded, partly developed

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 325.9 (38 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N.A.

ELEVATION MAXIMUM DESIGN POOL: 328.7

ELEVATION TOP DAM: 327.4

PRINCIPAL SPILLWAY CREST:

a. Elevation 325.9

b. Type Concrete chute

c. Width 9 feet

d. Length 37 feet

e. Location Spillover Across top of dam at north end

f. Number and Type of Gates None

AUXILIARY SPILLWAY CREST: Outlet works function as auxiliary spillway

a. Elevation 325.9

b. Type Sharp crested weir (stoplogs)

c. Width -

d. Length 3.9 feet

e. Location Spillover At centerline of dam

f. Number and Type of Gates One gate (stoplogs)

OUTLET WORKS: _____

a. Type Timber stoplogs

b. Location Adjacent to spillway

c. Entrance invert 316.5

d. Exit invert 316.5

e. Emergency draindown facilities: Pull stoplogs

HYDROMETEOROLOGICAL GAGES: None

a. Type N.A.

b. Location N.A.

c. Records N.A.

MAXIMUM NON-DAMAGING DISCHARGE:

(Lake stage equal to top of dam) 50 c.f.s.

# APPENDIX 4

Hydraulic/Hydrologic Computations

# HYDROLOGY

HYDROLOGIC ANALYSIS - RUNOFF HYDROGRAPH WILL BE DEVELOPED BY THE HEC-1-DB COMPUTER PROGRAM USING THE SCS TRIANGULAR UNIT HYDROGRAPH WITH THE CURVILINEAR TRANSFORMATION.

DRAINAGE AREA = 0.4 SQUARE MILES

INFILTRATION DATA:

INITIAL INFILTRATION = 1.0 IN

CONSTANT INFILTRATION = 0.1 IN./HOUR

TIME OF CONCENTRATION

BY CHART ON SCS, TR-55 OVERLAND FLOW

OVERLAND FLOW 4300 FT at 6%

CHANNEL FLOW 900 FT at 2%

$$T_C = \left(\frac{4300}{1.6} + \frac{900}{1.5}\right)\frac{1}{3600} = .75 + .17 = .92 \text{ HOURS}$$

## TIME OF CONCENTRATION - BY KERBY - PG 14-36
"HANDBOOK OF APPLIED HYDROLOGY" - CHOW

$$T_c^{2.14} = {}^2/_3 \, Lr / \sqrt{S}$$

WHERE: $T_c$ = overland time of concentration (min)
$L$ = length of overland flow (ft)
$r$ = Roughness coefficient ($r = 0.4$)
$S$ = Slope = 6 %

$$T_c^{2.14} = {}^2/_3 \, (4300)(0.4) / \sqrt{.06}$$

overland $T_c$ = 52 MINUTES = .87 HOURS
channel $T_c$ (from previous page) = .17 HOURS
1.0 HOURS

TOTAL $T_c$ = 1.0 HOURS

## TIME OF CONCENTRATION - BY CALIFORNIA CULVERTS PRACTICE
Ref: "DESIGN OF SMALL DAMS" pg 71

$$T_c = \left( \frac{11.9 \, L^3}{H} \right)^{0.385}$$

$$T_c = \left( \frac{11.9 (.98)^3}{275} \right)^{0.385}$$

$T_c$ = Time of concentration (hours)
$L$ = length of watercourse (miles)
$H$ = elevation difference in feet
$L = 5200'$
$H = 275'$

$T_c$ = 0.3 HOURS

## TIME OF CONCENTRATION - BY SNYDER Pg 135
"INTRODUCTION TO HYDROLOGY"
VIESSMAN ET. AL.

$t_t = C_t (LL_{ca})^{0.3}$ where:

$t_t$ = lag time (hours)
$C_t$ = coefficient representing variations of watershed slopes & storages
ave $C_t = 2.0$
$L$ = Length of main channel from outlet to divide (0.95 MILES)
$L_c$ = Length along main channel to a point opposite the watershed centroid (0.40 MILES)

$t_t = 2.0 (.40 \times .95)^{0.3}$

LAG = 1.5 HOURS

SNYDER'S METHOD GENERALLY NOT APPLICABLE TO DRAINAGE AREAS LESS THAN 10 SQUARE MILES ∴ $t_t$ = 1.5 WILL NOT BE CONSIDERED IN CHOOSING LAG TIME FOR COMPUTER INPUT

USE $T_C$ = 0.9 HOURS

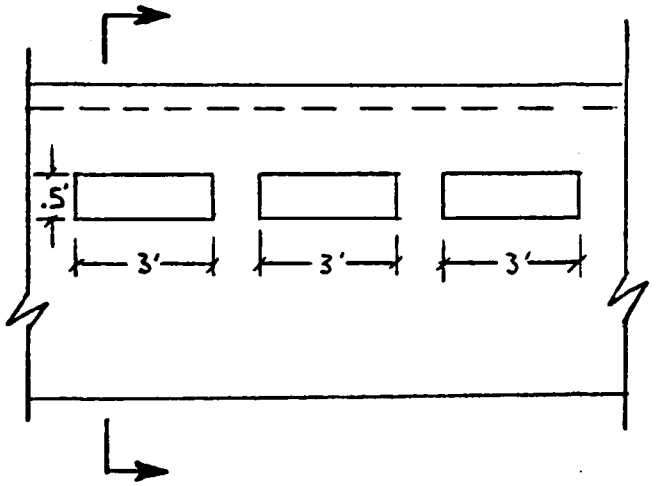
LAG TIME = 0.54 HOURS

# LAKE STORAGE VOLUME

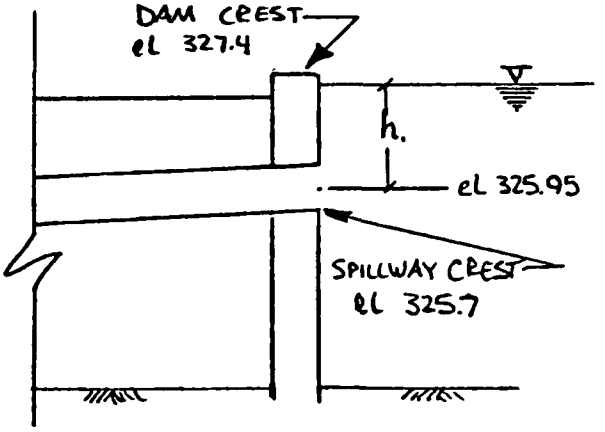
| ELEVATION (M.S.L.) | STORAGE (AC-FT) |
|---|---|
| 314.3 | 0 |
| 326.3 | 40 |
| 328 | 57 |
| 330 | 76 |
| 332 | 100 |
| 334 | 125 |

INFORMATION DETERMINED FROM SOUNDINGS TAKEN DURING FIELD INSPECTION AND AERIAL TOPOGRAPHICAL MAPS.

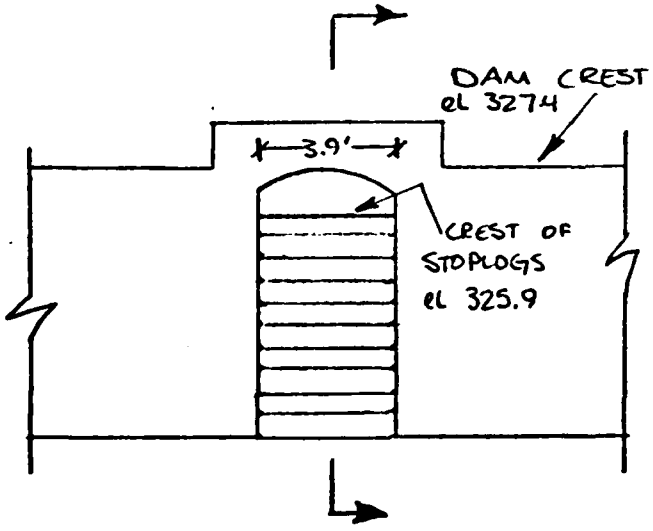
# HYDRAULICS



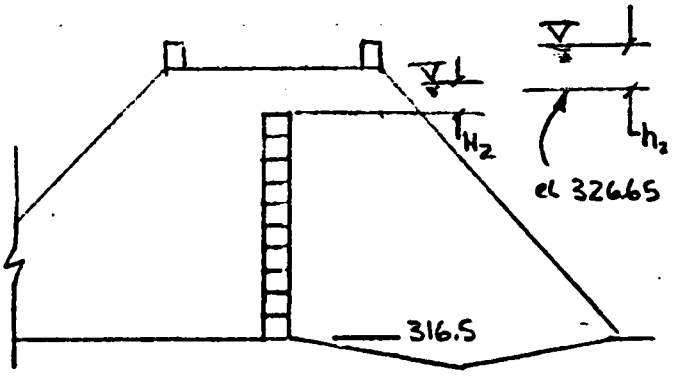

SPILLWAY ELEVATION




SPILLWAY SECTION




OUTLET WORKS ELEVATION




OUTLET WORKS SECTION

# STAGE DISCHARGE TABULATION

DISCHARGE AT THE SPILLWAY IS TREATED AS ORIFICE FLOW AT WATER LEVELS GREATER THAN 326.2 ($h_1 \geq 0.25'$) AT WATER LEVELS GREATER THAN 325.9 THERE IS ADDITIONAL UNCONTROLLED DISCHARGE OVER THE TIMBER STOPLOGS AT THE OUTLET WORKS. THIS DISCHARGE IS TREATED AS FLOW OVER A SHARP-CRESTED WEIR AT WATER LEVELS LESS THAN 327.4 ($H_2 \leq 1.5'$) AND AS ORIFICE FLOW AT WATER LEVELS GREATER THAN 327.4 ($h_2 \geq 0.75'$)

NOTE: DISCHARGE VALUES IN THE FOLLOWING TABULATION DO NOT INCLUDE OVERTOPPING OF 250' OF DAM CREST AS THIS WILL BE COMPUTED BY HEC-1-DB COMPUTER PROGRAM

# STAGE - DISCHARGE TABULATION (cont)

FORMULAS USED IN STAGE - DISCHARGE TABULATION ARE:

ORIFICE FLOW; $Q_{OR} = CA\sqrt{2gh}$ ; h = head for orifice

OVERTOPPING FLOW; $Q_{OV} = CLH^{3/2}$ ; H = head for overtopping

SPILLWAY
A = 4.5 SF
$C_{ORIFICE}$ = 0.6

OUTLET WORKS
A = 5.8 SF
$C_{ORIFICE}$ = 0.6
L = 3.9'
$C_{OVERTOPPING}$ = 3.3 (AVE FOR 0' < H < 8')

| WATER LEVEL | SPILLWAY DISCHARGE CREST EL 325.7 | | DISCHARGE AT OUTLET WORKS STOPLOGS CREST EL. 325.9 | | | | TOTAL DISCHARGE |
|---|---|---|---|---|---|---|---|
| | $h_1$ (ft) | $Q_{OR}$ (CFS) | $h_2$ (ft) | $Q_{OR}$ (CFS) | $H_2$ (ft | $Q_{OV}$ (CFS) | (CFS) |
| 325.7 | 0 | 0 | NA. | – | 0 | 0 | 0 |
| 326.2 | 0.25 | 10.8 | N.A. | - | 0.3 | 2.1 | 12.9 |
| 327 | 1.05 | 22.8 | NA | - | 1.1 | 14.8 | 37.0 |
| 327.4 | 1.45 | 26.1 | NA | - | 1.5 | 23.6 | 49.7 |
| 328 | 2.05 | 31.0 | 1.35 | 32.5 | NA | - | 63.5 |
| 329 | 3.05 | 37.8 | 2.35 | 42.8 | NA | - | 80.6 |
| 330 | 4.05 | 43.6 | 3.35 | 51.1 | NA | - | 94.7 |
| 331 | 5.05 | 48.7 | 4.35 | 58.2 | NA | - | 106.9 |
| 332 | 6.05 | 53.3 | 5.35 | 64.6 | NA | - | 117.9 |
| 333 | 7.05 | 57.6 | 6.35 | 70.4 | NA | - | 128.0 |
| 334 | 8.05 | 61.5 | 7.35 | 75.7 | NA | - | 137.2 |

N.A. = NOT APPLICABLE

* VALUES OF "C" WERE OBTAINED FROM THE "HANDBOOK OF HYDRAULICS" BY BRATER & KING

STORCH ENGINEERS

Sheet 8 of

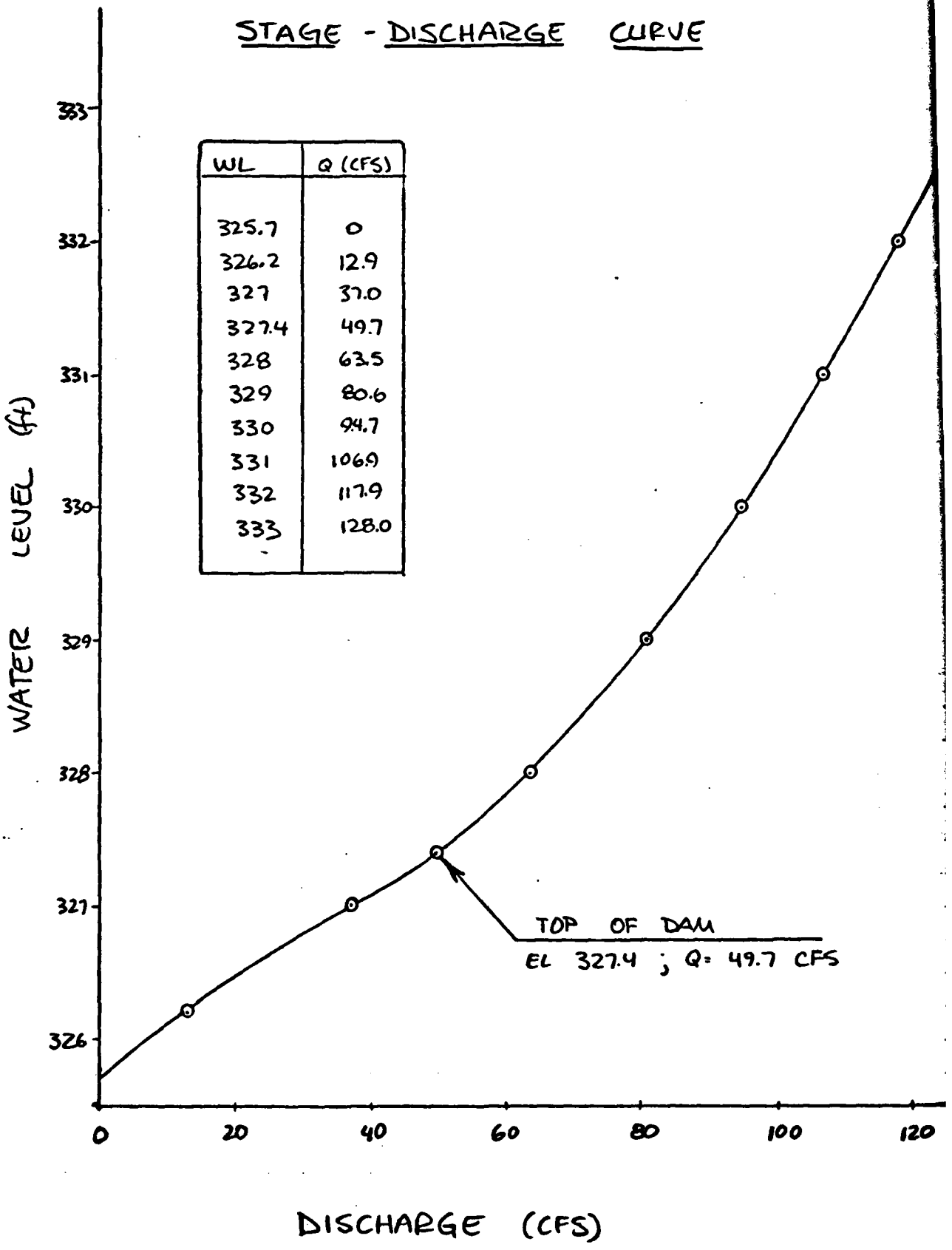
Project DE COZENS DAM

Made By STO Date 1/15/E

Chkd By RL Date 2/12

# STAGE - DISCHARGE CURVE

| WL | Q (CFS) |
|---|---|
| 325.7 | 0 |
| 326.2 | 12.9 |
| 327 | 37.0 |
| 327.4 | 49.7 |
| 328 | 63.5 |
| 329 | 80.6 |
| 330 | 94.7 |
| 331 | 106.9 |
| 332 | 117.9 |
| 333 | 128.0 |



# OUTLET WORKS CAPACITY

OUTLET WORKS CONSIST OF TWELVE STOPLOGS AT THE DOWNSTREAM END OF A CUT THROUGH THE DAM (SEE PLATE 6). ASSUME DRAWDOWN BY REMOVING 3 STOPLOGS AT A TIME UNTIL WATER LEVEL RECEDES TO TOP OF REMAINING STOPLOGS. DISCHARGE WILL BE CALCULATED AS FLOW OVER A SHARP-CRESTED WEIR ($C = 3.3$, $L = 3.9'$), USING THE EQUATION, $Q = CLH^{3/2}$. DEPTH AT OUTLET WORKS = 9.4', BY REMOVING 3 STOPLOGS AT A TIME, THE WEIR DROPS 2.4' AT EACH INCREMENT. THE AVERAGE HEAD, $H_{AVE}$ 1.2' ($C_{AVE} = 3.3$)

MAXIMUM $Q = CLH^{3/2} = (3.3)\,3.9\,(2.4)^{3/2}$

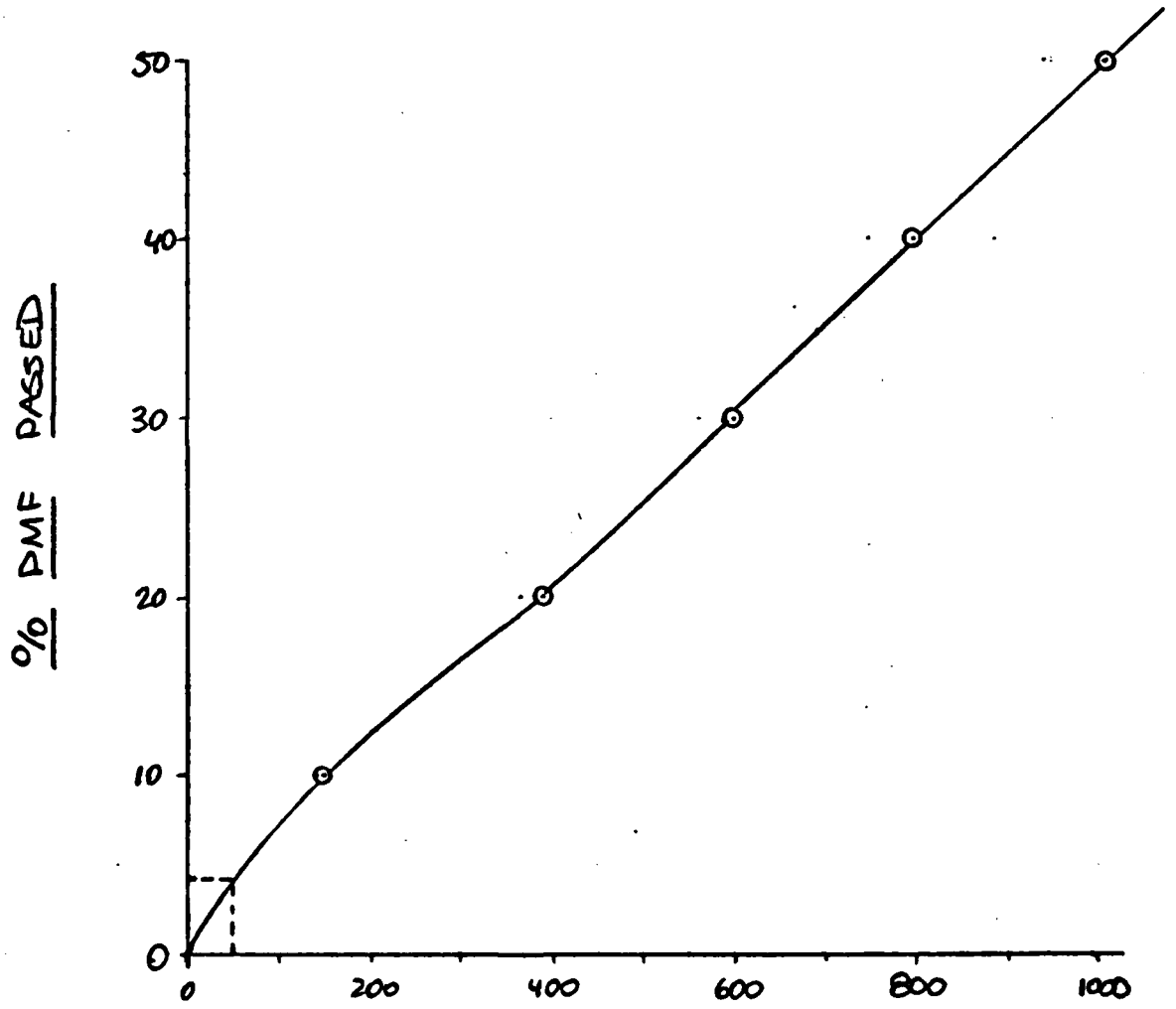
MAXIMUM DISCHARGE = 48 CFS

AVERAGE $Q = C_{AVE}\,L\,H_{AVE}^{3/2} = (3.3)\,3.9\,(1.2)^{3/2} = 17$ CFS

$$\text{DRAWDOWN} = \frac{\text{STORAGE}}{\text{AVERAGE DISCHARGE}} = \frac{38\ \text{AC-FT}\ (43560\ ^{SF}/_{AC})}{17\ \text{CFS}\ (3600\ ^{SEC}/_{HR})}$$

DRAWDOWN = 27.0 HOURS = 1.1 DAYS

# OVERTOPPING POTENTIAL



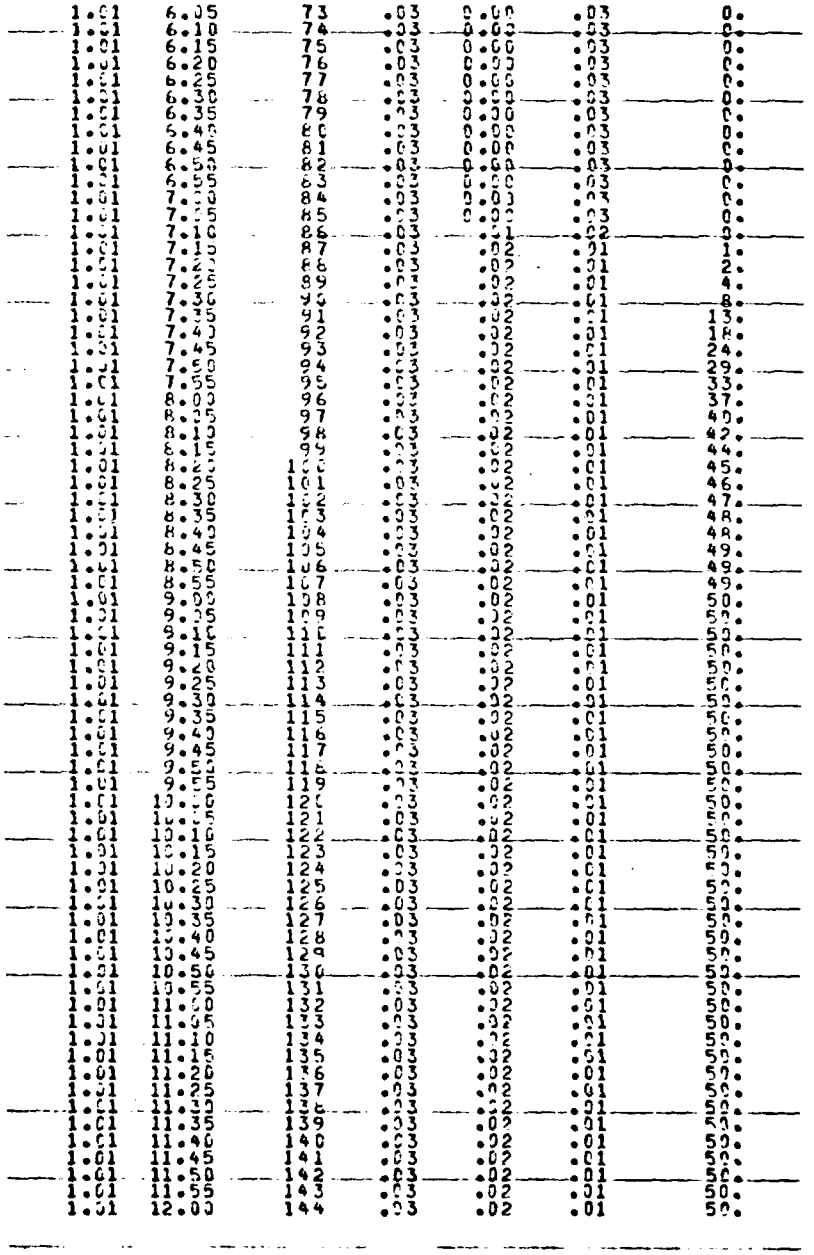

OVERTOPPING OF THE DAM OCCURS AT ELEVATION 327.4, WITH Q= 50 CFS ∴ DAM CAN PASS APPROXIMATELY 4.2 % PMF OR 8.4 % SDF

# HEC-1-DB COMPUTATIONS

```
A1                    NATIONAL DAM SAFTY PROGRAM
A2              DE COZENS DAM
A3              MULTI RATIO PMF ROUTING
3       15.0          0         5
31          5
J           1         5         1
J1      0.5         0.4       0.3       0.2       0.1
K           0     LAKE                    0         0         1
K1              INFLOW HYDROGRAPH TO LAKE
M           1         2      0.38                 0.38         0                   1
P           0      25.5       100       109       117
T                                                            1.0       0.1
T2                 0.54
X       -1.0      -0.05       2.0
K           1         DAM                 0         0         1
K1              ROUTE DISCHARGE THROUGH DAM
Y                                     1         1
Y1          1                                            -325.9        -1
Y4    325.7     326.2       327     327.4       328       329       330       331       332       333
Y5          0        13        37        50        64        81        95       107       120       137
$S          0        40        57        76       100       125
$E    314.3     326.3       328       330       332       334
$$    325.7
$D    327.4      2.63       1.5       250
K          99
A
A
A
A
A
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE= 80/01/23.
     TIME= 15.30.50.

                    NATIONAL DAM SAFTY PROGRAM
                  DE COZENS DAM
                  MULTI RATIO PMF ROUTING

                              JOB SPECIFICATION
      NQ      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
     150       0        5        0        0        0        0        0        0        0
                                JOPER      NWT    LROPT    IRACE
                                    5        0        0        0

                        MULTI-PLAN ANALYSES TO BE PERFORMED
                                NPLAN= 1 NRTIO= 5 LRTIO= 1
          RTIOS=     .50      .40      .30      .20      .10

**********          **********          **********          **********          **********

                              SUB-AREA RUNOFF COMPUTATION

          INFLOW HYDROGRAPH TO LAKE

                        ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE    IAUTO
                        LAKE         0        0        0        0        0        1        0        0

                                HYDROGRAPH DATA
        IHYDG     IUHG    TAREA     SNAP     IRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
            1        2      .38     0.00      .38     0.00    0.000        0        1        0

                                PRECIP DATA
                     SPFE      PMS       R6       R12      R24      R48      R72      R96
                     0.00    25.50   100.00   109.00   117.00     0.00     0.00     0.00
TRSPC COMPUTED BY THE PROGRAM IS  .800

                                LOSS DATA
      LROPT    STRKR    DLTKR    RTIOL    ERAIN    STRKS    RTIOK    STRTL    CNSTL    ALSMX    RTIMP
          0     0.00     0.00     1.00     0.00     0.00     1.00     1.00      .10     0.00     0.00

                              UNIT HYDROGRAPH DATA
                          TC=  0.00    LAG=   .54

                                RECESSION DATA
                     STRTQ=    -1.00    QRCSN=    -.05    RTIOR= 2.00

     UNIT HYDROGRAPH 34 END OF PERIOD ORDINATES, TC=    0.00 HOURS, LAG=     .54  VOL= 1.00
       19.      56.     113.     192.     264.     305.     315.     304.     274.     236.
      186.     141.     111.      88.      71.      57.      44.      35.      28.      22.
       17.      14.      11.       9.       7.       5.       4.       3.       3.       2.
        2.       1.       1.       0.
```

| MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|---|---|---|---|---|---|---|
| 1.01 | .05 | 1 | .01 | 0.00 | .01 | 0. |
| 1.01 | .10 | 2 | .01 | 0.00 | .01 | 0. |
| 1.01 | .15 | 3 | .01 | 0.00 | .01 | 0. |
| 1.01 | .20 | 4 | .01 | 0.00 | .01 | 0. |
| 1.01 | .25 | 5 | .01 | 0.00 | .01 | 0. |
| 1.01 | .30 | 6 | .01 | 0.00 | .01 | 0. |
| 1.01 | .35 | 7 | .01 | 0.00 | .01 | 0. |
| 1.01 | .40 | 8 | .01 | 0.00 | .01 | 0. |
| 1.01 | .45 | 9 | .01 | 0.00 | .01 | 0. |
| 1.01 | .50 | 10 | .01 | 0.00 | .01 | 0. |
| 1.01 | .55 | 11 | .01 | 0.00 | .01 | 0. |
| 1.01 | 1.00 | 12 | .01 | 0.00 | .01 | 0. |
| 1.01 | 1.05 | 13 | .01 | 0.00 | .01 | 0. |
| 1.01 | 1.10 | 14 | .01 | 0.00 | .01 | 0. |
| 1.01 | 1.15 | 15 | .01 | 0.00 | .01 | 0. |
| 1.01 | 1.20 | 16 | .01 | 0.00 | .01 | 0. |
| 1.01 | 1.25 | 17 | .01 | 0.00 | .01 | 0. |
| 1.01 | 1.30 | 18 | .01 | 0.00 | .01 | 0. |
| 1.01 | 1.35 | 19 | .01 | 0.00 | .01 | 0. |
| 1.01 | 1.40 | 20 | .01 | 0.00 | .01 | 0. |
| 1.01 | 1.45 | 21 | .01 | 0.00 | .01 | 0. |
| 1.01 | 1.50 | 22 | .01 | 0.00 | .01 | 0. |
| 1.01 | 1.55 | 23 | .01 | 0.00 | .01 | 0. |
| 1.01 | 2.00 | 24 | .01 | 0.00 | .01 | 0. |
| 1.01 | 2.05 | 25 | .01 | 0.00 | .01 | 0. |
| 1.01 | 2.10 | 26 | .01 | 0.00 | .01 | 0. |
| 1.01 | 2.15 | 27 | .01 | 0.00 | .01 | 0. |
| 1.01 | 2.20 | 28 | .01 | 0.00 | .01 | 0. |
| 1.01 | 2.25 | 29 | .01 | 0.00 | .01 | 0. |
| 1.01 | 2.30 | 30 | .01 | 0.00 | .01 | 0. |
| 1.01 | 2.35 | 31 | .01 | 0.00 | .01 | 0. |
| 1.01 | 2.40 | 32 | .01 | 0.00 | .01 | 0. |
| 1.01 | 2.45 | 33 | .01 | 0.00 | .01 | 0. |
| 1.01 | 2.50 | 34 | .01 | 0.00 | .01 | 0. |
| 1.01 | 2.55 | 35 | .01 | 0.00 | .01 | 0. |
| 1.01 | 3.00 | 36 | .01 | 0.00 | .01 | 0. |
| 1.01 | 3.05 | 37 | .01 | 0.00 | .01 | 0. |
| 1.01 | 3.10 | 38 | .01 | 0.00 | .01 | 0. |
| 1.01 | 3.15 | 39 | .01 | 0.00 | .01 | 0. |
| 1.01 | 3.20 | 40 | .01 | 0.00 | .01 | 0. |
| 1.01 | 3.25 | 41 | .01 | 0.00 | .01 | 0. |
| 1.01 | 3.30 | 42 | .01 | 0.00 | .01 | 0. |
| 1.01 | 3.35 | 43 | .01 | 0.00 | .01 | 0. |
| 1.01 | 3.40 | 44 | .01 | 0.00 | .01 | 0. |
| 1.01 | 3.45 | 45 | .01 | 0.00 | .01 | 0. |
| 1.01 | 3.50 | 46 | .01 | 0.00 | .01 | 0. |
| 1.01 | 3.55 | 47 | .01 | 0.00 | .01 | 0. |
| 1.01 | 4.00 | 48 | .01 | 0.00 | .01 | 0. |
| 1.01 | 4.05 | 49 | .01 | 0.00 | .01 | 0. |
| 1.01 | 4.10 | 50 | .01 | 0.00 | .01 | 0. |
| 1.01 | 4.15 | 51 | .01 | 0.00 | .01 | 0. |
| 1.01 | 4.20 | 52 | .01 | 0.00 | .01 | 0. |
| 1.01 | 4.25 | 53 | .01 | 0.00 | .01 | 0. |
| 1.01 | 4.30 | 54 | .01 | 0.00 | .01 | 0. |
| 1.01 | 4.35 | 55 | .01 | 0.00 | .01 | 0. |
| 1.01 | 4.40 | 56 | .01 | 0.00 | .01 | 0. |
| 1.01 | 4.45 | 57 | .01 | 0.00 | .01 | 0. |
| 1.01 | 4.50 | 58 | .01 | 0.00 | .01 | 0. |
| 1.01 | 4.55 | 59 | .01 | 0.00 | .01 | 0. |
| 1.01 | 5.00 | 60 | .01 | 0.00 | .01 | 0. |
| 1.01 | 5.05 | 61 | .01 | 0.00 | .01 | 0. |
| 1.01 | 5.10 | 62 | .01 | 0.00 | .01 | 0. |
| 1.01 | 5.15 | 63 | .01 | 0.00 | .01 | 0. |
| 1.01 | 5.20 | 64 | .01 | 0.00 | .01 | 0. |
| 1.01 | 5.25 | 65 | .01 | 0.00 | .01 | 0. |
| 1.01 | 5.30 | 66 | .01 | 0.00 | .01 | 0. |
| 1.01 | 5.35 | 67 | .01 | 0.00 | .01 | 0. |
| 1.01 | 5.40 | 68 | .01 | 0.00 | .01 | 0. |
| 1.01 | 5.45 | 69 | .01 | 0.00 | .01 | 0. |
| 1.01 | 5.50 | 70 | .01 | 0.00 | .01 | 0. |
| 1.01 | 5.55 | 71 | .01 | 0.00 | .01 | 0. |
| 1.01 | 6.00 | 72 | .01 | 0.00 | .01 | 0. |



| MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|---|---|---|---|---|---|---|
| 1.01 | 12.05 | 145 | .17 | .16 | .01 | 53. |
| 1.01 | 12.10 | 146 | .17 | .16 | .01 | 61. |
| 1.01 | 12.15 | 147 | .17 | .16 | .01 | 78. |
| 1.01 | 12.20 | 148 | .17 | .16 | .01 | 105. |
| 1.01 | 12.25 | 149 | .17 | .16 | .01 | 144. |
| 1.01 | 12.30 | 150 | .17 | .16 | .01 | 188. |
| 0.00 | 0.00 | 151 | .17 | .16 | .01 | 233. |
| 0.00 | 0.00 | 152 | .17 | .16 | .01 | 277. |
| 0.00 | 0.00 | 153 | .17 | .16 | .01 | 317. |
| 0.00 | 0.00 | 154 | .17 | .16 | .01 | 351. |
| 0.00 | 0.00 | 155 | .17 | .16 | .01 | 378. |
| 0.00 | 0.00 | 156 | .17 | .16 | .01 | 398. |
| 0.00 | 0.00 | 157 | .20 | .20 | .01 | 415. |
| 0.00 | 0.00 | 158 | .20 | .20 | .01 | 429. |
| 0.00 | 0.00 | 159 | .20 | .20 | .01 | 443. |
| 0.00 | 0.00 | 160 | .20 | .20 | .01 | 458. |
| 0.00 | 0.00 | 161 | .20 | .20 | .01 | 474. |
| 0.00 | 0.00 | 162 | .20 | .20 | .01 | 489. |
| 0.00 | 0.00 | 163 | .20 | .20 | .01 | 504. |
| 0.00 | 0.00 | 164 | .20 | .20 | .01 | 517. |
| 0.00 | 0.00 | 165 | .20 | .20 | .01 | 529. |
| 0.00 | 0.00 | 166 | .20 | .20 | .01 | 539. |
| 0.00 | 0.00 | 167 | .20 | .20 | .01 | 547. |
| 0.00 | 0.00 | 168 | .20 | .20 | .01 | 553. |
| 0.00 | 0.00 | 169 | .26 | .25 | .01 | 559. |
| 0.00 | 0.00 | 170 | .26 | .25 | .01 | 565. |
| 0.00 | 0.00 | 171 | .26 | .25 | .01 | 574. |
| 0.00 | 0.00 | 172 | .26 | .25 | .01 | 586. |
| 0.00 | 0.00 | 173 | .26 | .25 | .01 | 602. |
| 0.00 | 0.00 | 174 | .26 | .25 | .01 | 619. |
| 0.00 | 0.00 | 175 | .26 | .25 | .01 | 636. |
| 0.00 | 0.00 | 176 | .26 | .25 | .01 | 653. |
| 0.00 | 0.00 | 177 | .26 | .25 | .01 | 667. |
| 0.00 | 0.00 | 178 | .26 | .25 | .01 | 680. |
| 0.00 | 0.00 | 179 | .26 | .25 | .01 | 690. |
| 0.00 | 0.00 | 180 | .26 | .25 | .01 | 697. |
| 0.00 | 0.00 | 181 | .16 | .15 | .01 | 701. |
| 0.00 | 0.00 | 182 | .31 | .30 | .01 | 703. |
| 0.00 | 0.00 | 183 | .31 | .30 | .01 | 704. |
| 0.00 | 0.00 | 184 | .47 | .46 | .01 | 709. |
| 0.00 | 0.00 | 185 | .54 | .53 | .01 | 724. |
| 0.00 | 0.00 | 186 | 1.32 | 1.31 | .01 | 773. |
| 0.00 | 0.00 | 187 | 2.17 | 2.16 | .01 | 869. |
| 0.00 | 0.00 | 188 | .85 | .84 | .01 | 1075. |
| 0.00 | 0.00 | 189 | .54 | .53 | .01 | 1329. |
| 0.00 | 0.00 | 190 | .47 | .46 | .01 | 1622. |
| 0.00 | 0.00 | 191 | .31 | .30 | .01 | 1878. |
| 0.00 | 0.00 | 192 | .31 | .30 | .01 | 2038. |
| 0.00 | 0.00 | 193 | .24 | .23 | .01 | 2094. |
| 0.00 | 0.00 | 194 | .24 | .23 | .01 | 2057. |
| 0.00 | 0.00 | 195 | .24 | .23 | .01 | 1945. |
| 0.00 | 0.00 | 196 | .24 | .23 | .01 | 1783. |
| 0.00 | 0.00 | 197 | .24 | .23 | .01 | 1591. |
| 0.00 | 0.00 | 198 | .24 | .23 | .01 | 1410. |
| 0.00 | 0.00 | 199 | .24 | .23 | .01 | 1253. |
| 0.00 | 0.00 | 200 | .24 | .23 | .01 | 1143. |
| 0.00 | 0.00 | 201 | .24 | .23 | .01 | 1049. |
| 0.00 | 0.00 | 202 | .24 | .23 | .01 | 971. |
| 0.00 | 0.00 | 203 | .24 | .23 | .01 | 909. |
| 0.00 | 0.00 | 204 | .24 | .23 | .01 | 861. |
| 0.00 | 0.00 | 205 | .19 | .18 | .01 | 821. |
| 0.00 | 0.00 | 206 | .19 | .18 | .01 | 788. |
| 0.00 | 0.00 | 207 | .19 | .18 | .01 | 757. |
| 0.00 | 0.00 | 208 | .19 | .18 | .01 | 729. |
| 0.00 | 0.00 | 209 | .19 | .18 | .01 | 700. |
| 0.00 | 0.00 | 210 | .19 | .18 | .01 | 673. |
| 0.00 | 0.00 | 211 | .19 | .18 | .01 | 647. |
| 0.00 | 0.00 | 212 | .19 | .18 | .01 | 624. |
| 0.00 | 0.00 | 213 | .19 | .18 | .01 | 604. |
| 0.00 | 0.00 | 214 | .19 | .18 | .01 | 588. |
| 0.00 | 0.00 | 215 | .19 | .18 | .01 | 575. |
| 0.00 | 0.00 | 216 | .19 | .18 | .01 | 565. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 217 | .01 | .01 | .01 | 553. |
| 0.00 | 0.00 | 218 | .01 | .01 | .01 | 536. |
| 0.00 | 0.00 | 219 | .01 | .01 | .01 | 511. |
| 0.00 | 0.00 | 220 | .01 | .01 | .01 | 473. |
| 0.00 | 0.00 | 221 | .01 | .01 | .01 | 423. |
| 0.00 | 0.00 | 222 | .01 | .01 | .01 | 368. |
| 0.00 | 0.00 | 223 | .01 | .01 | .01 | 312. |
| 0.00 | 0.00 | 224 | .01 | .01 | .01 | 258. |
| 0.00 | 0.00 | 225 | .01 | .01 | .01 | 209. |
| 0.00 | 0.00 | 226 | .01 | .01 | .01 | 168. |
| 0.00 | 0.00 | 227 | .01 | .01 | .01 | 135. |
| 0.00 | 0.00 | 228 | .01 | .01 | .01 | 110. |
| 0.00 | 0.00 | 229 | .01 | .01 | .01 | 100. |
| 0.00 | 0.00 | 230 | .01 | .01 | .01 | 93. |
| 0.00 | 0.00 | 231 | .01 | .01 | .01 | 87. |
| 0.00 | 0.00 | 232 | .01 | .01 | .01 | 81. |
| 0.00 | 0.00 | 233 | .01 | .01 | .01 | 75. |
| 0.00 | 0.00 | 234 | .01 | .01 | .01 | 70. |
| 0.00 | 0.00 | 235 | .01 | .01 | .01 | 66. |
| 0.00 | 0.00 | 236 | .01 | .01 | .01 | 61. |
| 0.00 | 0.00 | 237 | .01 | .01 | .01 | 57. |
| 0.00 | 0.00 | 238 | .01 | .01 | .01 | 53. |
| 0.00 | 0.00 | 239 | .01 | .01 | .01 | 50. |
| 0.00 | 0.00 | 240 | .01 | .01 | .01 | 46. |
| 0.00 | 0.00 | 241 | .01 | .01 | .01 | 43. |
| 0.00 | 0.00 | 242 | .01 | .01 | .01 | 40. |
| 0.00 | 0.00 | 243 | .01 | .01 | .01 | 38. |
| 0.00 | 0.00 | 244 | .01 | .01 | .01 | 35. |
| 0.00 | 0.00 | 245 | .01 | .01 | .01 | 33. |
| 0.00 | 0.00 | 246 | .01 | .01 | .01 | 31. |
| 0.00 | 0.00 | 247 | .01 | .01 | .01 | 29. |
| 0.00 | 0.00 | 248 | .01 | .01 | .01 | 27. |
| 0.00 | 0.00 | 249 | .01 | .01 | .01 | 25. |
| 0.00 | 0.00 | 250 | .01 | .01 | .01 | 23. |
| 0.00 | 0.00 | 251 | .01 | .01 | .01 | 22. |
| 0.00 | 0.00 | 252 | .01 | .01 | .01 | 20. |
| 0.00 | 0.00 | 253 | .01 | .01 | .01 | 19. |
| 0.00 | 0.00 | 254 | .01 | .01 | .01 | 18. |
| 0.00 | 0.00 | 255 | .01 | .01 | .01 | 16. |
| 0.00 | 0.00 | 256 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 257 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 258 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 259 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 260 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 261 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 262 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 263 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 264 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 265 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 266 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 267 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 268 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 269 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 270 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 271 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 272 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 273 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 274 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 275 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 276 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 277 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 278 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 279 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 280 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 281 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 282 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 283 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 284 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 285 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 286 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 287 | .01 | .01 | .01 | 15. |
| 0.00 | 0.00 | 288 | .01 | .01 | .01 | 15. |
| | | SUM | 23.87 | 21.18 | 2.69 | 62635. |
| | | | ( 606.) | ( 538.) | ( 68.) | ( 1773.63) |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 2094. | 786. | 218. | 218. | 62656. |
| CMS | 59. | 22. | 6. | 6. | 1774. |
| INCHES | | 19.25 | 21.31 | 21.31 | 21.31 |
| MM | | 488.83 | 541.18 | 541.18 | 541.18 |
| AC-FT | | 390. | 432. | 432. | 432. |
| THOUS CU M | | 481. | 532. | 532. | 532. |

HYDROGRAPH AT STA LAKE FOR PLAN 1, RTIO 1

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 1. | 2. | 4. | |
| 7. | 9. | 12. | 14. | 17. | 18. | 20. | 21. | 22. | 23. |
| 23. | 24. | 24. | 24. | 24. | 25. | 25. | 25. | 25. | 25. |
| 25. | 25. | 25. | 25. | 25. | 25. | 25. | 25. | 25. | 25. |
| 25. | 25. | 25. | 25. | 25. | 25. | 25. | 25. | 25. | 25. |
| 25. | 25. | 25. | 25. | 25. | 25. | 25. | 25. | 25. | 25. |
| 25. | 25. | 25. | 25. | 27. | 31. | 39. | 53. | 72. | 94. |
| 117. | 139. | 158. | 175. | 189. | 199. | 207. | 215. | 222. | 229. |
| 237. | 244. | 252. | 259. | 265. | 270. | 273. | 276. | 279. | 283. |
| 287. | 293. | 301. | 309. | 318. | 326. | 334. | 340. | 345. | 349. |
| 351. | 352. | 352. | 354. | 362. | 387. | 444. | 537. | 664. | 811. |
| 939. | 1019. | 1047. | 1028. | 973. | 892. | 795. | 705. | 632. | 572. |
| 525. | 486. | 454. | 430. | 411. | 394. | 379. | 364. | 350. | 336. |
| 324. | 312. | 302. | 294. | 287. | 282. | 276. | 268. | 255. | 236. |
| 212. | 184. | 156. | 129. | 105. | 84. | 67. | 55. | 50. | 46. |
| 43. | 40. | 38. | 35. | 33. | 31. | 29. | 27. | 25. | 23. |
| 22. | 20. | 19. | 18. | 16. | 15. | 14. | 13. | 12. | 12. |
| 11. | 10. | 9. | 9. | 8. | 8. | 8. | 8. | 8. | 8. |
| 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. |
| 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. |
| 8. | 8. | 8. | 8. | 8. | 8. | 8. | 8. | | |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 1047. | 393. | 109. | 109. | 31333. |
| CMS | 30. | 11. | 3. | 3. | 887. |
| INCHES | | 9.62 | 10.65 | 10.65 | 10.65 |
| MM | | 244.42 | 270.59 | 270.59 | 270.59 |
| AC-FT | | 195. | 216. | 216. | 216. |
| THOUS CU M | | 240. | 266. | 266. | 266. |

**********  **********  **********  **********  **********

## HYDROGRAPH ROUTING

ROUTE DISCHARGE THROUGH DAM

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| DAM | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|---|---|---|---|---|---|---|---|
| 0.0 | 0.000 | 0.00 | 1 | 1 | 0 | 0 | 0 |

| NSIPS | NSTOL | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | -326. | -1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| STAGE | 325.70 | 326.20 | 327.00 | 327.40 | 328.00 | 329.00 | 330.00 | 331.00 | 332.00 | 333.00 |
| FLOW | 0.00 | 13.00 | 37.00 | 50.00 | 64.00 | 81.00 | 95.00 | 107.00 | 120.00 | 137.00 |
| CAPACITY= | 0. | 40. | 57. | 76. | 100. | 125. | | | | |
| ELEVATION= | 314. | 326. | 328. | 330. | 332. | 334. | | | | |

| CREL | SPWID | COQW | EXPW | ELEVL | COQL | CAREA | EXPL |
|---|---|---|---|---|---|---|---|
| 325.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COQD | EXPD | DAMWID |
|---|---|---|---|
| 327.4 | 2.6 | 1.5 | 250. |

STATION DAM, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 5. | 5. | 5. | 4. | 4. | 4. | 4. | 4. | 4. | 4. |
| 3. | 3. | 3. | 3. | 3. | 3. | 3. | 3. | 3. | 2. |
| 2. | 2. | 2. | 2. | 2. | 2. | 2. | 2. | 2. | 2. |
| 2. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. |
| 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. |
| 1. | 1. | 1. | 1. | 1. | 1. | 1. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 1. | 1. | 1. | 2. | 3. | 3. | 4. | 5. | 6. | 7. |
| 8. | 8. | 9. | 10. | 11. | 11. | 12. | 13. | 14. | 14. |
| 15. | 15. | 15. | 16. | 16. | 16. | 16. | 17. | 17. | 17. |
| 17. | 17. | 17. | 18. | 18. | 18. | 18. | 18. | 18. | 18. |
| 19. | 19. | 19. | 19. | 19. | 19. | 19. | 19. | 20. | 20. |
| 20. | 20. | 20. | 21. | 20. | 20. | 21. | 21. | 22. | 23. |
| 25. | 27. | 30. | 32. | 35. | 39. | 42. | 46. | 50. | 77. |
| 116. | 153. | 184. | 209. | 228. | 242. | 253. | 261. | 268. | 273. |
| 278. | 282. | 288. | 295. | 302. | 310. | 318. | 326. | 333. | 338. |
| 343. | 346. | 349. | 351. | 354. | 363. | 386. | 433. | 513. | 625. |
| 756. | 879. | 966. | 1007. | 1003. | 962. | 895. | 815. | 736. | 665. |
| 605. | 555. | 514. | 479. | 452. | 429. | 409. | 392. | 377. | 362. |
| 349. | 336. | 324. | 313. | 304. | 296. | 290. | 283. | 275. | 264. |
| 249. | 230. | 208. | 185. | 163. | 141. | 122. | 105. | 92. | 82. |
| 74. | 67. | 62. | 58. | 55. | 52. | 50. | 50. | 49. | 49. |
| 48. | 47. | 47. | 46. | 46. | 45. | 44. | 44. | 43. | 42. |
| 42. | 41. | 41. | 40. | 39. | 38. | 38. | 37. | 36. | 36. |
| 35. | 35. | 34. | 34. | 33. | 32. | 32. | 31. | 31. | 31. |
| 30. | 30. | 29. | 29. | 28. | 28. | 27. | 27. | 27. | 26. |
| 26. | 26. | 25. | 25. | 24. | 24. | 24. | 23. | | |

STORAGE

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 39. | 39. | 39. | 39. | 39. | 39. | 39. | 38. | 38. | 38. |
| 38. | 38. | 38. | 38. | 38. | 38. | 39. | 38. | 38. | 38. |
| 38. | 38. | 38. | 38. | 38. | 38. | 38. | 38. | 38. | 38. |
| 38. | 38. | 38. | 38. | 38. | 38. | 38. | 38. | 38. | 38. |
| 38. | 38. | 38. | 38. | 38. | 38. | 39. | 38. | 38. | 38. |
| 38. | 38. | 38. | 38. | 38. | 38. | 38. | 38. | 38. | 38. |
| 38. | 38. | 38. | 38. | 38. | 38. | 38. | 38. | 38. | 38. |
| 38. | 38. | 38. | 38. | 38. | 38. | 38. | 38. | 38. | 38. |
| 38. | 38. | 38. | 38. | 38. | 38. | 39. | 39. | 39. | 39. |
| 39. | 39. | 39. | 39. | 39. | 39. | 40. | 40. | 40. | 40. |
| 40. | 40. | 40. | 40. | 40. | 40. | 40. | 40. | 40. | 40. |
| 40. | 40. | 40. | 41. | 41. | 41. | 41. | 41. | 41. | 41. |
| 41. | 41. | 41. | 41. | 41. | 41. | 41. | 41. | 41. | 41. |
| 41. | 41. | 41. | 41. | 41. | 41. | 42. | 42. | 42. | 42. |
| 43. | 44. | 45. | 45. | 46. | 48. | 49. | 50. | 51. | 52. |
| 53. | 54. | 54. | 55. | 55. | 55. | 55. | 56. | 56. | 56. |
| 56. | 56. | 56. | 56. | 56. | 56. | 56. | 57. | 57. | 57. |
| 57. | 57. | 57. | 57. | 57. | 57. | 57. | 58. | 59. | 60. |
| 61. | 62. | 63. | 63. | 63. | 63. | 62. | 62. | 61. | 60. |
| 60. | 59. | 59. | 58. | 58. | 58. | 57. | 57. | 57. | 57. |
| 57. | 57. | 56. | 56. | 56. | 56. | 56. | 56. | 56. | 56. |
| 55. | 55. | 55. | 54. | 54. | 54. | 53. | 53. | 53. | 52. |
| 52. | 52. | 52. | 51. | 51. | 51. | 51. | 51. | 51. | 51. |
| 50. | 50. | 50. | 50. | 50. | 49. | 49. | 49. | 49. | 49. |
| 48. | 48. | 48. | 48. | 47. | 47. | 47. | 47. | 47. | 47. |
| 46. | 46. | 46. | 46. | 46. | 45. | 45. | 45. | 45. | 45. |
| 45. | 45. | 44. | 44. | 44. | 44. | 44. | 44. | 44. | 43. |
| 43. | 43. | 43. | 43. | 43. | 43. | 43. | 42. | | |

STAGE

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 325.9 | 325.9 | 325.9 | 325.9 | 325.9 | 325.9 | 325.9 | 325.8 | 325.8 | 325.8 |
| 325.8 | 325.8 | 325.8 | 325.8 | 325.8 | 325.8 | 325.8 | 325.8 | 325.8 | 325.8 |
| 325.8 | 325.8 | 325.8 | 325.8 | 325.8 | 325.8 | 325.8 | 325.8 | 325.8 | 325.8 |
| 325.8 | 325.8 | 325.8 | 325.8 | 325.8 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 |
| 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 |
| 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 |
| 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 |
| 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 | 325.7 |
| 325.7 | 325.7 | 325.7 | 325.8 | 325.8 | 325.8 | 325.9 | 325.9 | 325.9 | 326.0 |
| 326.0 | 326.0 | 326.1 | 326.1 | 326.1 | 326.1 | 326.2 | 326.2 | 326.2 | 326.2 |
| 326.3 | 326.3 | 326.3 | 326.3 | 326.3 | 326.3 | 326.3 | 326.3 | 326.3 | 326.3 |
| 326.3 | 326.3 | 326.3 | 326.4 | 326.4 | 326.4 | 326.4 | 326.4 | 326.4 | 326.4 |
| 326.4 | 326.4 | 326.4 | 326.4 | 326.4 | 326.4 | 326.4 | 326.4 | 326.4 | 326.4 |
| 326.4 | 326.4 | 326.4 | 326.4 | 326.4 | 326.4 | 326.5 | 326.5 | 326.5 | 326.5 |
| 326.6 | 326.7 | 326.8 | 326.8 | 326.9 | 327.1 | 327.2 | 327.3 | 327.4 | 327.5 |
| 327.6 | 327.7 | 327.7 | 327.8 | 327.8 | 327.8 | 327.8 | 327.9 | 327.9 | 327.9 |
| 327.9 | 327.9 | 327.9 | 327.9 | 327.9 | 327.9 | 327.9 | 327.9 | 328.0 | 328.0 |
| 328.0 | 328.0 | 328.0 | 328.0 | 328.0 | 328.0 | 328.0 | 328.1 | 328.2 | 328.3 |
| 328.4 | 328.5 | 328.6 | 328.7 | 328.7 | 328.6 | 328.6 | 328.5 | 328.4 | 328.3 |
| 328.3 | 328.2 | 328.2 | 328.1 | 328.1 | 328.1 | 328.0 | 328.0 | 328.0 | 328.0 |
| 328.0 | 328.0 | 327.9 | 327.9 | 327.9 | 327.9 | 327.9 | 327.9 | 327.9 | 327.9 |
| 327.8 | 327.8 | 327.8 | 327.7 | 327.7 | 327.7 | 327.6 | 327.6 | 327.6 | 327.5 |
| 327.5 | 327.5 | 327.5 | 327.4 | 327.4 | 327.4 | 327.4 | 327.4 | 327.4 | 327.4 |
| 327.3 | 327.3 | 327.3 | 327.3 | 327.3 | 327.2 | 327.2 | 327.2 | 327.2 | 327.2 |
| 327.1 | 327.1 | 327.1 | 327.1 | 327.1 | 327.0 | 327.0 | 327.0 | 327.0 | 327.0 |
| 326.9 | 326.9 | 326.9 | 326.9 | 326.9 | 326.8 | 326.8 | 326.8 | 326.8 | 326.8 |
| 326.8 | 326.8 | 326.7 | 326.7 | 326.7 | 326.7 | 326.7 | 326.7 | 326.7 | 326.6 |
| 326.6 | 326.6 | 326.6 | 326.6 | 326.6 | 326.6 | 326.6 | 326.5 | | |

PEAK OUTFLOW IS 1007. AT TIME 16.17 HOURS

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 1007. | 380. | 107. | 107. | 30797. |
| CMS | 29. | 11. | 3. | 3. | 872. |
| INCHES | | 9.29 | 10.47 | 10.47 | 10.47 |
| MM | | 236.07 | 265.96 | 265.96 | 265.96 |
| AC-FT | | 188. | 212. | 212. | 212. |
| THOUS CU M | | 232. | 262. | 262. | 262. |

## SUMMARY OF DAM SAFETY ANALYSIS

| ******** | | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|---|
| | ELEVATION | 325.90 | 325.70 | 327.40 |
| | STORAGE | 39. | 38. | 61. |
| | OUTFLOW | 5. | C. | 50. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .50 | 328.66 | 1.26 | 63. | 1007. | 6.58 | 16.17 | 0.00 |
| .40 | 328.47 | 1.07 | 61. | 800. | 6.08 | 16.25 | 0.00 |
| .30 | 328.26 | .86 | 60. | 596. | 5.50 | 16.25 | 0.00 |
| .20 | 328.03 | .63 | 57. | 391. | 4.50 | 16.25 | 0.00 |
| .10 | 327.67 | .27 | 54. | 149. | 2.67 | 16.50 | 0.00 |

# APPENDIX 5

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